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EDUCATIONAL MEASUREMENT AND THE TEACHING OF SCIENCE.[1]

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We have been asked to discuss the relation of educational measurement to the problems of teaching. In approaching this problem it may be profitable first to consider the general and specific meanings which the term measurement carries in current educational discussion. In a broad sense measurement implies the handling of materials in a quantitative rather than a merely qualitative sense. Educational discussion has concerned itself primarily with what one may term simple qualitative analysis. It has relied upon apriori methods and has generalized individual instances. It is only in recent years that students in education have undertaken to apply mathematics to their problems and to deal with their data quantitatively.

A subject is not necessarily unscientific because it is qualitative. In the beginning all our natural and physical sciences have been qualitative sciences merely. They have been concerned with analysis and differentiation of materials. Sooner or later, however, physics, chemistry, biology, psychology, and recently education and sociology have sought to apply to their data mathematical criteria. The advantages of the applications of mathematics are very great and scientific men do not feel that they have made satisfactory progress in reducing their phenomena to scientific terms until they can state the behavior of such phenomena according to the laws of logic and of mathematics. The history of science is largely the story of successful attempts to measure natural phenomena. In a broad sense, the phrase educational measurement implies this general procedure of all science in reducing its phenomena to mathematical statement. Educational measurement is the application of

[1]Read before the general session of the C. A. S. & M. T. Hyde Park High School, Chicago, Dec. 1, 1922.

mathematical criteria to the aims, processes and products of education.

Probably for most persons, however, the term educational measurement implies the specific uses of mathematics involved in so-called statistical methods as these have been developed in recent investigations. It means to treat the phenomena of education in terms of frequencies, averages, medians, variabilities, and coefficients of relationship. Its instruments are standard tests and scales and specialized mathematical formulae, the number, variety and usefulness of which are constantly increasing. In spirit it tries to substitute objectively verifiable fact and experimental analysis for subjective opinion and the merely qualitative discussion of educational problems. It calls in question many time-honored theories and beliefs, insists that hypotheses shall be submitted to experimental demonstration and that educational philosophies and procedures shall be evaluated in terms of definable products.

No one doubts that the interest in educational measurements in this specific sense is today widespread both as to the fields covered and the personnel engaged in the work. It has all the earmarks of an educational movement—individual proponents, official journals, training centers, and voluble critics. The growing numbers of young men who are coming to regard a knowledge of the technique of measurement as an essential element of their training is good evidence of the intellectual vigor of the movement and the increasing number of teachers and administrators who are turning to measurement for guidance in the concrete problems of the day's work is an indication of its practical usefulness.

Enough has now been done in the development of measurement methods and in applying these methods to the solution of school problems for us to work out certain broad lines along which the applications of measurement to teaching may with profit proceed. We can see certain outstanding problems and see the lines of investigation necessary to their solution. In the case of the teaching of science and mathematics most of the work lies ahead, but the way to travel is fairly obvious.

What, then, are the immediate tasks of measurement in the field of science and mathematics teachings? Certainly, one of the first is the construction of the measuring instruments. Standardized tests and scales in these fields are few and cover but small ranges of teaching materials. In making this statement

I am not unmindful that some work has been done, and that, in some respects science teachers have been more active in applying the methods of science to their teaching problems than have many other secondary school groups. The work of Camp and Glenn in physics, of Powers in chemistry, and of Hotz in algebra are excellent beginnings which make use of recently developed technique in the field of measurement. These authors themselves, however, would hardly claim that the field of science teaching has been covered either as to the information which these sciences seek to impart or as to the mental processes which the study of science supposedly involves.

Until the means of study and investigation have been devised little can be done in the way of applying measurement to teaching problems, but the mere multiplication of standard tests in any field will not suffice the needs of investigation. Such tests must be devised to solve particular problems and must be specific in character. As an illustration of what this means we may refer to tests for measuring the results of teaching, i. e., subject matter tests. It is not sufficient that an examination be concerned with the subject in general. It must be devised to measure the specific curriculum in that subject and the particular methods employed in the particular case under consideration. The Hotz algebra scales, for instance, are inadequate to measure the results of teaching general mathematics at the end of the first year of work, because they presuppose a different curriculum and different methods of instruction. A satisfactory test in general mathematics must be based on the curriculum in general mathematics and its standards must be in terms of such a curriculum. A good illustration of correct procedure in scale making in this regard is the work of Ashbaugh in making the Iowa spelling scales. In the construction of these scales, the author made use of elaborate studies of social usage in the writing of English so as to determine the fundamental elements of the spelling curriculum. He went further and studied not merely the difficulty of spelling the words but the difficulty of *learning to spell* the words. Upon the results of these investigations the spelling scales were constructed.

Again subject-matter tests must be differential and diagnostic. It is not sufficient to have a standard test in arithmetic. There must be tests for fundamentals of arithmetic and tests for ability to solve arithmetical problems. But fundamentals imply a variety of processes—addition, subtraction, multiplica-

tion, division. Nor is addition simple. On the contrary it is highly complex, and measures, adequate for experimental purposes, must cover every elemental process which it involves and which is crucial in the acquisition of skill. It is not enough, therefore, to have general scales which measure mass results but there must be differential tests to measure specific and elemental processes down to the simplest activity which is in any sense determinative of the total result. The Freeman scales in handwriting, the Van Wagenan scales in English composition are illustrations in point.

Certainly the teaching of secondary school science and mathematics is not less complex than that of the subjects just mentioned nor does a satisfactory program for scientific study of its problems imply a less comprehensive and differential set of measuring devices. If teachers of these subjects propose seriously to study their problems by scientific methods they must face the task of constructing an elaborate array of measuring instruments.

We may forego at this point any discussion of the mathematics of scale and test construction by merely remarking that the methods of scale-making are none too satisfactory or reliable and by implying that the most refined methods must be used. Upon one further point, however, we may for a moment dwell. Many of the so-called subject-matter tests are equivocal in the results which they give, because they measure activities other than those which they pretend to measure. Skills in a particular subject are complicated with other abilities and skills in such a fashion that these other abilities and skills often determine the score in the subject-matter test. Until we know in how far a subject-matter test measures these other functions we cannot know its value in measuring the specific abilities involved in the subject itself. The two kinds of complicating factors which are most pervasive are the undetermined and variable reading abilities which pupils possess and the part which general native capacities play in the acquisition and possession of specific skills in school subjects. If we are clearly to evaluate the results of educational processes we must know in how far these two factors complicate the results of educational tests and scales. No scale or set of scales is finally satisfactory until we isolate from it these two factors and evaluate them by the methods of partial correlation and experimental analysis.

Enough has now been done in other fields so that students

working in the fields of science and mathematics teaching may proceed with considerable assurance in appropriating the technique elsewhere developed. In the development of measuring instruments the problem is largely, in the beginning, the application of this technique to the materials peculiar to science and mathematics, a somewhat routine and prosaic task but a necessary one if these fields of teaching are to avail themselves of recent advances in scientific study.

Granting that we have or may have valid tests and scales, we may next inquire as to the service which such tests may render. What are the questions which they will enable us to answer: First, may be placed all those questions which have to do with the achievements of pupils and their school progress. Professor Foley's recent paper on the College Student's Knowledge of High School Physics sets a typical problem of this sort. What information and skill does a student get from his high school course in physics? Professor Foley implies, although he does not so far commit himself in print, that such students get almost nothing from such high school study. He reports less than twenty percent correctness in an examination of ten problems, this score "being the weighted average of the grades made by 851 students who had studied physics for one year in the high school." He further notes that students who have not had high school physics achieve an average mark in college physics of 72.6, while those who have had high school physics average only 77.7, a difference of but five per cent in favor of the latter group. The writer leaves the figures to tell their own story, but he quotes with apparent approval from his colleagues in college work such statements as the following: "For a long time I have been certain that our students bring no physics with them when they enter my classes." "Personally, I have not been able to see much difference in the grades of students who have had high school physics and those who have not." "It is indeed disappointing that our present high school teaching of physics is shown to be such a complete failure." "The study confirms my view that the benefit derived from high school physics is discouragingly small," and "In my opinion the difference in grades is a fair argument in favor of dropping the work in physics in the high schools." If Professor Foley differs from these statements he fails to say so in his published statement. His paper on its face constitutes an indictment of high school instruction made all the more deadly by its use of objective measures.

Who is to answer to this charge? Who, but the teacher of high school physics? Is it true that your pupils learn nothing, or next to nothing, by a year of study with you? If true, how can you justify your professional existence and the expensive buildings and laboratories which you require in these days of the increasing costliness of education? But be perfectly assured that you can not answer this indictment by merely pleading "not guilty," nor by elaborate philosophizing on the aims of education, or eloquent discourses on the virtues of formal discipline. At the end of every such emotional orgy you will be faced by the figures showing that eighty per cent of the information called for by Professor Foley's questions is unknown by your students when they reach college halls. In the face of such facts you will be seriously hampered in any rhetorical apology for your existence or your work. If such figures stand unrefuted as an expression of the total result of the teaching of physics to high school students there seems little for high school physics teachers to do but to resign and do penance for past offenses.

What then can be the answer to this serious charge of non-productivity of high school teaching? If not rhetoric and philosophy, then what? Facts, verifiable facts, which refute or explain the apparent results of Professor Foley's study. Unless these can be produced, his facts will stand as an unaccepted challenge, and the high school teachings of physics will be widely questioned by the educational world and by the general public.

What then is the method of reply? It is first of all a critical examination of his method of measurement. Do his ten questions constitute a valid measure of the results of physics teaching? In pursuit of this general question it may be asked, are the questions used in his examination representative of the field of information covered by high school courses in physics? Upon this question which in itself would require an elaborate investigation, the writer gives us no light. Are the questions of such a character as to represent the content of the college course in physics? The author gives no information. Does success in this test indicate the ability to do the college course in physics? No information. Are the several questions of equal value as measures of high school achievement? Are they of equal value in predicting success in college physics? Are they equal in difficulty of solution? In how far is ability to answer any or all the questions of this test a function of intelligence and in how far is it a product of instruction? How reliable are these tests in their

capacity to give identical results on successive trials? What is their discriminative capacity? What is the value of the text as an instrument of indirect measurement; i. e., what does failure in the test indicate beyond the mere fact of failure in the test? Do the tests furnish as good a prognosis of success in college physics as do high school marks in physics? Upon these and scores of other technical questions which one asks about his tests and methods of work the writer gives us no information whatever. He does not even tell us whether these same students who failed so miserably at the beginning of his course do any better after a year in his classes. (To the average college professor such a question is, of course, sacrilege.)

In the light of so many unnoted, but crucial experimental conditions, the significance of which will be recognized by any student of experimental education, but little credence can be placed in the results. They may indicate a real condition; they may not. No one can tell? Certainly not a mere reader of Professor Foley's paper. One may easily surmise what Professor Foley would do with a physics student who was so indifferent to essential experimental method as was he in his attack upon this educational problem.

To say that Professor Foley proposes no real solution of the problem which he states does not deny that he has sensed a real problem—one upon which properly conducted educational measurement may in the long run throw a great deal of light. What is the product of science teaching in the schools? What skills and information do students have after studying science which they would not otherwise have?

If pupils do not retain details of information, do they acquire any habits of lasting value as a result of studying mathematics or science? No person with a genuine scientific spirit will rest his faith in these matters upon personal opinion, nor will he be content to accept endless discussion for verifiable facts.

It may not be amiss at this point to call attention to results obtained by Mr. Powers for the subject of Chemistry which are quite different from those reported by Professor Foley for Physics. The pertinence of these results lies in the closeness with which the high school scores approximate those of the college classes. The median score for the 731 high school cases was 54 while that for two college groups which had studied Chemistry a full year was 67 and 69, respectively. In fact more than 75 percent of all the high school scores came within the range of

the university scores. These contradictory results were obtained by methods much more acceptable to experimental education than those used in the physics study.

It is not here desired to evaluate these studies or to determine the validity of their findings. They are used as illustrations of the type of investigations in which the technique of educational measurement must be employed to obtain dependable results.

The use of educational measurements in measuring the results of teaching is not confined to the evaluation of the end product of instruction. Tests must be so devised as to be used in the day by day procedure of classroom work. With a curriculum satisfactorily devised it should be possible to measure the value of each day's work and to determine its contribution to the final achievement of a pupil. It should also be possible to determine the amount of time required to teach a defined curriculum to pupils of a determined capacity up to a determined level of efficiency. Something like this has already been done by Mr. Reeve in the case of first year mathematics. From results experimentally obtained it appears that first year high school pupils, having a median mental age of 17.3 years and a median intelligence quotient of 126, can acquire the skill required in the first chapter of the Reeve and Schorling text in a total of fourteen lessons of forty-five minutes each so that on a test of thirty-one problems they achieve a score of twenty-three with an average variation of 3.5 problems, and on another test of seventeen problems they achieve a median score of thirteen with an A. D. of 3.2 problems.

Another group of problems constantly before the schools concerns the methods of science teaching. What place should the laboratory be given in high school science? How much do students profit from formal lectures in science? Do students gain more from simple apparatus representing elemental principles or from perfected machines exemplifying the refinements of physical engineering? What is the relative importance of demonstration and experimentation? Do the learning habits of boys differ sufficiently from those of girls to justify different methods of teaching in science? Should the requisite mathematics be taught in a prerequisite course or with the facts of science?

Any alert teacher can multiply such questions as these *ad libitum*. None, however, can give a definite answer to any one of them. Are they insoluble? Not at all. They remain unsolved because we have not had the necessary experimental conditions

for investigation, or we have not had the initiative to set ourselves to the task. While the technic of instruction is a matter complicated beyond most of our problems, it, too, can be approached by the methods of experimental analysis and educational measurement and many perennial controversies that refuse to terminate by discussion will yield themselves to the finality of objective facts.

And finally, the methods of educational measurement will help us to construct a curriculum. They will help us to exclude from the curriculum facts which are common knowledge and therefore too simple to interest students as instructional problems. When fifty per cent of pupils in eighth grade classes already know of 300 topics treated in general science text books, as Mr. Dvorak has found to be approximately the case in an examination of pupils, it is obviously undesirable to include such materials in a curriculum designed for high school freshmen. Measurements will discover for us the things which are so difficult that pupils of a particular mental development can not learn them. When only 8.7 per cent of seven hundred high school pupils can write correctly the equation for the chemical change which occurs in the laboratory preparation of ammonia using ammonium chloride, or only twelve per cent of high school graduates who have studied physics one year know what is meant by the statement that the specific heat of iron is 0.113, it is evidence of the great difficulty of such questions for these students. If the same results obtain after these subjects had been taught under experimental conditions by the best available teaching technic the conclusion could hardly be avoided that these items were too difficult in character for persons of the maturity and training of high school students. Such methods will help to determine the place in a curriculum where a particular subject can most effectively be taught, to indicate the necessary subdivisions of a subject, to fix prerequisites and to organize material into a teachable program.

It seems like carrying coals to Newcastle to speak to men engaged in the pursuit of science and mathematics about applying the methods of science and mathematics to their own problems. Observation, experimental analysis, exact records, measurement of results, verification of hypotheses, quantitative treatment of data, these are but aspects of the methods which have enabled students to understand natural phenomena and to construct modern science.

UNIFORM CIRCULAR MOTION.

By W. W. Sleator,
University of Wisconsin, Madison.

For a long time after I had studied the sections on circular motion in my first course in college physics, there seemed to me something paradoxical in our description of that kind of motion. It was uniform motion, and the moving particle described the same number of centimeters in each succeeding second. Yet, though the number of centimeters per second remained the same, there was said to be an acceleration, expressed in centimeters per second per second. This meant that the number of centimeters per second changed continuously. How could the number of centimeters per second remain the same and still continuously change? I did not venture to present this difficulty in class, for the sections I studied were devoted to showing, not that there was an acceleration, still less why there was one, but that $a = v^2/r$, and then that centrifugal force equaled mv^2/r. It is true that in class something was said about this circular acceleration, to the effect that it was perpendicular to the motion, and that the velocity changed in direction, though not in magnitude. But it seemed to me that any change in the direction of a motion should be expressed in angular units, and might be in radians per second, or degrees per centimeter, rather than in centimeters per second per second. I confess that this difficulty about circular motion remained with me, even after I had studied Ziwet's Mechanics, when certainly it should have been removed, and I must own to having many times taught the subject in the very way which had proved to me unsatisfactory. The book which I studied gave surprisingly little insight into circular motion—other texts use some variation of the hodograph idea, and, though it seems to me now that they might do better in another way, any one of them might have given me the light my groping vision seemed to require.

We must bear in mind, I think, that the function of a proof which we assign as a lesson for classes is not limited to logical demonstration. It may serve to convince a trained opponent, yet be ill adapted to lead and teach the student. He is by no means skeptical, but rather gullible—too willing to believe what we tell him, not because he is convinced but because he is indifferent. If we teach somewhat formally, as certainly I was taught, we are all the more obliged to present plain and enlighten-

ing material—as Mr. Franklin has insisted, to be exacting and unintelligible is a capital offense. A proof or demonstration should be so constructed that there is a plain reason, not only why a statement is true, but also why that statement is made. We can take no satisfaction in convincing by argument one who may be as well convinced by assertion. To do that is to accomplish nothing. We ought to teach how an argument is constructed, in the hope that the student may some time be able as well as inclined to make one for himself. According to these principles, though I know that you teach uniform circular motion better than I used to do, I am going to explain how I now think it may best be done. But in the first place let me suggest that you sometime frame up an examination question something like this—"A particle having uniform circular motion moves through the same number of centimeters every second. How then can it have an acceleration expressed in centimeters per second per second?

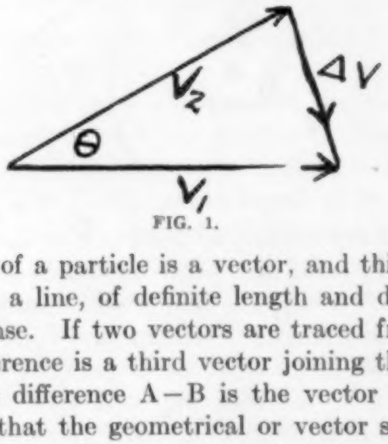


FIG. 1.

The velocity of a particle is a vector, and this is, or may be represented by, a line, of definite length and direction, traced in a definite sense. If two vectors are traced from a common, point their difference is a third vector joining the separate end points. Or the difference A−B is the vector which must be added to B so that the geometrical or vector sum is A. Evidently A and B may have the same length or magnitude yet (if they are not parallel) have a difference. This difference will be a vector with the same physical meaning as A and B. Hence two velocities (e. g. of a point in uniform circular motion) will differ by a velocity. Though their absolute values are the same, so that they are equal in centimeters per second, yet the magnitude of their difference is expressed in centimeters per second. $\triangle V$ in Fig. 1 is a velocity, the difference between V_1 and V_2, though V_1 and V_2 are numerically equal. All this is simple, almost obvious, but by no means unessential. A student will never understand uniform circular motion until this is under-

stood. He may, of course, be just as willing to *learn* uniform circular motion in some other way, and without any reference to vectors at all.

Now suppose that V_1 and V_2 (in Fig. 2) are velocities at nearby points on the circumference of a circle. The particle has required a time Δt to get from P_1 to P_2. It is perhaps an extension of previous ideas, but it is certainly no contradiction to them to say that the acceleration at P_1 is the limit, as t approaches zero, of $(V_1 - V_2)/\Delta t$, or of $\Delta V/\Delta t$. From Fig 1 numerical values are given by $\Delta V = 2V_1 \sin \theta/2$, and, as Δt approaches zero, ΔV approaches $V\theta$, so that $\Delta V/\Delta t$ approaches $V\theta/\Delta t$. Now θ equals the angle at the center of the circle between OP_1 and OP_2, and since the angular velocity is uniform $V\Delta\theta/\Delta t = V\omega$.

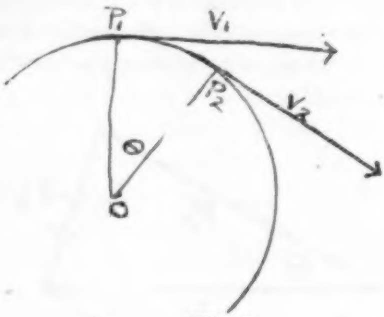


FIG. 2.

This limit is, by our definition, the value of the acceleration of the particle at P_1 or at any point on the circumference of the circle, since $\omega = V/r$ we have now proved that $a = V^2/r = \omega^2 r$. It would have been almost as well to have considered the sector OP_1P_2 to approach in the limit a triangle similar to that formed by V_1, V_2, and ΔV, and then we could write $V\Delta t : r = \Delta V : V$, so that $V^2\Delta t = \Delta V r$, or $\Delta V/\Delta t = V^2/r$, as before. This way enables us to avoid trigonometry but I think obscures a little the ideas involved. We should note that the acceleration *a* is perpendicular to V, or is directed toward the center, because in the limiting condition ΔV is perpendicular to V. It is plain also that if a is not directed along the radius it will have a component in the direction of the tangent, parallel to V, on account of which V will either be decreased or increased. This is impossible, since V is constant, and accordingly a is directed toward the center.

I claim, of course, no originality in this demonstration, but I feel on that account all the more free to urge its excellence and

its advantages. It completely removes such difficulties as I encountered. It presents the fundamental ideas frankly, instead of obscuring them. It paves the way for an easy mastery of the determination of acceleration in general curvilinear motion and it makes good use of the idea of vectors, which here proves itself practical and fruitful.

An interesting problem suggests itself in connection with this discussion. Suppose we take two points 180 apart on the circumference of the circle. At these points the velocities are equal and opposite and their difference is 2V. The time elapsing between the assumptions of these two velocities is $\frac{1}{2}T$, T being the period of the motion, and since $V = 2\pi r/T$, $T = 2\pi r/V$. If we define the average acceleration during the interval as $V_1 - V_2/t$ we should have

$$\text{av. acc.} = 2V/(\tfrac{1}{2}2\pi r/V) = 2/\pi V^2/r = 0.636V^2/r.$$

Again, supposing the points 90 apart, $V_1 - V_2 = \sqrt{2}V$ and $t = T/4 = 2\pi r/4V$ so that

$$\text{av. acc.} = \sqrt{2}V/(2\pi r/4V) = \sqrt{2}\,2/\pi V^2/r = 0.900\ V^2/r.$$

Similarly, if the angle is 30, $V_1 - V_2 = 0.517\ V$ and $t = 1/12T$, and av. acc. $= 0.99\ V^2/r$.
Of course the smaller the angle is chosen the nearer the average acceleration comes out to V^2/r. It may be remarked now that the acceleration in uniform circular motion is constant, yet its instantaneous value (V^2/r) is not equal to its average value. This seems contradictory again, for if a quantity does not change any, the average of its values during any interval equals any one or every one of its instantaneous values. But it is plain now that anyone led into this confusion is ignoring the fact that acceleration, as well as velocity, is a vector, and it does not remain constant if its direction changes.

We may also very well question our definition of average acceleration as $(V_1 - V_2)/t$. This certainly applies to the case of linear motion but to state it arbitrarily for other cases is perhaps unjustifiable. The average of any number of quantities is their sum divided by their number. If the quantities are vectors and the sum is their vector sum, then the average may very well not be equal to one of them, even if they are numerically equal.

If we consider the case of uniform circular motion and take the accelerations during a quarter period we may use a series of vectors representing accelerations at equal intervals, say 6 for the quadrant, of which the first and last will be at right

angles. These, added vectorially, give the sum S, as in Fig. 3. It is plain that the number of such vectors available is infinite and we can never take them all. But as we take into consideration more and more of them, always equally separated along the arc of the circle, they remain equal, and the first and last vectors of the set remain at right angles, so that the whole figure, as it grows bigger and bigger, comes nearer and nearer to having the proportions of a quadrant arc and its chord. The average is, of course, the vector sum divided by the number, and as we approach the limit this approaches infinity divided by infinity. But from the figure we have, if N is the number of terms,
(N times absolute value of one vector)/(S, or absolute value of sum) = arc/chord.

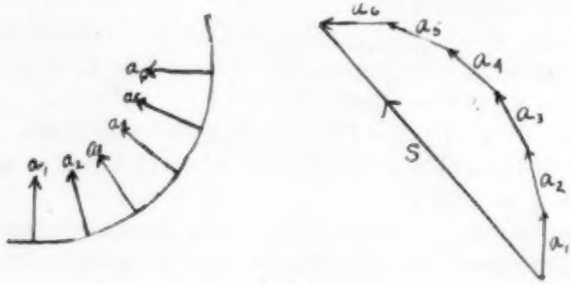


FIG. 3.

Therefore S/N = (chord/arc) times absolute value of one vector. Therefore, according to our ordinary idea of averages, the average acceleration during a quarter period is (chord/quadrant arc) times absolute value of the acceleration. The chord is $\sqrt{2}r$ and the arc is $2\pi r/4$, and the average is $2\sqrt{2}/\pi \; V^2/r$. This is just what we got by writing Av. Acc. = $(V_1 - V_2)/t$. That equation seems to be justified by its accord with our more fundamental one.

The problem or exercise which I suggested a while ago is more specifically this. Let a student take successive pairs of points nearer and nearer together, find the values of $a = (V_1 - V_2)/t$, and observe from his own answers that the values are not equal to V^2/r, but that they come nearer to V^2/r as the points approach each other. I believe that this will give one a better idea of what circular motion and its acceleration really mean than anything else.

I hope you are ready to agree with me that a frank consideration of vectors offers the best way to teach the subject of uniform circular motion. I should, however, be loath to present the

subject in this way after it had been originally given in another, It is not likely that students will make objection to any method and if they learn some ostensible proof of the equation $a = V^2/4$ they will very likely dislike to study a second one. One may have the discouraging experience of hearing a boy say that he understood the subject all right before he heard the new explanation of it. It is hard to help anyone over a difficulty which he himself has not encountered. However, I can mention one further advantage which this method possesses, and with this I leave it. We define simple harmonic motion as the motion of the projection, on the diameter of a circle, of a point having uniform motion on the circumference. We use this definition in order to express displacement, velocity and acceleration in terms of time and the constants of the motion, and finally to prove that the acceleration is proportional to the displacement and opposite in sign. The definition must then imply that the displacement of the particle having the S. H. M. is the projection of the displacement of the particle having the U. C. M., the velocity of one is the projection of the velocity of the other, and the acceleration of one the projection of the acceleration of the other. We can project these quantities only if they are vectors. Therefore, to teach uniform circular motion without the use of vectors is to leave the student completely at a loss when he requires that kind of motion as an introduction to the other.

EDUCATION OPPORTUNITY ALL THE YEAR ROUND.

The effect of long vacations has begun to excite serious apprehension. A few cities are solving the vacation problem by running the schools the entire year. Newark, N. J., may be given as an example. In that city many of the elementary schools and one high school are in session 48 weeks in a year.

The children who attend all the year like the plan. One boy says: "Going to school all year keeps you from hanging around the streets and saves you from trouble." A mother living in a tenement district says: "If there were no summer schools I would not know the whereabouts of my children. They would leave home early in the morning and run all over the city."

A school physician says: "There is less sickness among the school children in summer than in winter. The children who attend during summer are in better physical condition in September than the children who have not been to school."

A few other cities have organized all-year schools. Most cities conduct summer schools of 6 weeks, which is a step toward the all-year school. The all-year school is coming. Why not? It must, however, not be a school of mere text-books, but a school where children may live normal lives in working with their hands, in studying, and in playing.

AN AID IN KEEPING HIGH SCHOOL CHEMISTRY CLASS-WORK INTERESTING.

By L. K. Replogle,

Parker High School, Dayton, Ohio.

After a few months study of elementary high school chemistry a portion of the pupils lose interest in the recitation period and the outside preparation, even though they continue to enjoy the laboratory work. This condition arises to some extent, from the organization of the subject matter which is handled in most texts by families. After learning the occurrence, preparation, properties, and uses of a goodly number of elements and compounds, the student finds the remembering of this information about additional chemical substances quite monotonous. This is particularly true when the subject is taught by a teacher who has taught little chemistry and as a result follows the text book very closely. Older teachers overcome this tendency in many ways. They have a wider knowledge of industrial chemistry and can often transform the class from a state of boredom to intense interest by describing some particular chemical application they have seen and studied at first hand. Also, they have gathered a group of lecture table demonstrations that are very helpful. Then, finally, in many little ways, due to an acquired knack of teaching, they succeed in holding attention with material that would fail when presented by a less skillful teacher.

There will be no method found that will remedy all the wrongs of present chemistry teaching; but by combining the ideas that have been unusually successful for individual teachers, a steady improvement will naturally take place. Just as a good lecture table experiment makes for effective teaching, so the writer has found that a good problem of the nature indicated in this article helps in keeping the work up to the desired standard. No teacher thinks of using the lecture table demonstrations, to the exclusion of everything else, even though a few now and then are splendid. Neither does the writer think that all chemistry should be studied by the method presented here, but that occasionally this type of problem is a fine thing. The idea was used at Middletown, Ohio, in a school of about 400 students and also at Lima, Ohio, in Central High School which had then 1,575 students.

Take the study of sulphur to illustrate how the typical procedure may be varied and yet as much, if not more information

imparted. Usually the chapter on sulphur considers its occurrence, the method of extraction, its uses, and its more important compounds. All these are stressed in the following problem and if they are not made clear enough, the teacher can emphasize them in a logical review of the important information concerning sulphur. The problem was stated, "What sulphur industry will prove to have been the best investment ten years from to-day?" The students, of course, worked out the solution, suggesting the manner of attack in class and reading all available material outside of the recitation period, in order to gain the information needed to reach a just conclusion. The work can be done very satisfactorily on this problem if encyclopedias, textbooks, and "The Triumphs and Wonders of Modern Chemistry" by Geoffery Martin are the only available books. A brief outline of the solution as reached by the pupils follows:

What sulphur industry will prove to have been the best investment ten years from today?

I. Advantages and disadvantages of each.
  A. Sicily (deposits in Italy included under this heading).
    1. Advantages.
      a. Labor cheap and dependent.
      b. Inexhaustable supply (400,000 tons in 1900).
      c. Splendid shipping conditions.
    2. Disadvantages.
      a. Labor set against improvement.
      b. Method very wasteful.
        1′ Description of method showing waste of sulphur and labor.
          1″ Ore carried from open pits to kiln by hand.
          2″ Arrangement of calceroni.
          3″ Danger if temperature rises above 180°C of plastic sulphur forming. 35 to 80 days required to complete process. Here the instructor can perform experiments to show the four varieties of sulphur and the properties of each.
          4″ Man's method illustrated on a large scale by accident at Sommatino. The pit caught fire and after a long period of burning discharged 40,000 tons of pure sulphur into a stream below.
        2′ Calcerone burning prohibited during the garden season as 30% of the sulphur forms sulphur dioxide which would kill all growing material.
      c. Product is quite impure.

1′ The average ore yields about 30% sulphur.
2′ Distillation is often needed to obtain sulphur of satisfactory purity. Here the retort method is considered and flowers of sulphur are made.

d. Poor business methods. The man who reported the advance made in the Louisiana company's method was discharged when he advised a similar change.

B. Louisiana.
1. Advantages.
a. Excellent method—careful study of Frasch method made here.
b. Method shows business is well managed.
c. Sulphur found in accessible condition for this method though it is under 700 feet of quicksand. Its condition is pure.
d. Shipping conditions are fairly good.
2. Disadvantages.
a. Supply will not last indefinitely.
b. Labor is expensive.

C. Japan.
1. Advantages.
a. Pure condition.
b. No expensive method necessary.
c. Supply being replaced by nature. Study made here of cause of formation of sulphur in volcanoes.
2. Disadvantages.
a. Far from market.
b. Snow over it 9 months a year.

D. Wyoming (deposits not extensive enough to consider at length here).

II. Factors essential to the success of the industry.
(These are listed and the students compare the various industries on each point to see which has the advantage.)
A. Sufficient supply.
B. Available labor.
C. Good business organization.
D. Fairly pure product.
E. Satisfactory shipping conditions.
F. Available markets (more plainly, what causes the demand for sulphur and where is this demand created?).
1. Lime sulphur spray is used extensively in the grape industry and on fruit trees. Nature of the spray is

noted here. The students reached the conclusion that Sicily and Louisana each had a fair division of this portion of the market.

2. Gun powder uses a part of the product as it is made of potassium nitrate, carbon and sulphur. The use of sulphur in gunpowder is considered here from a chemical standpoint. Again the market appears to be available to Sicily and Louisana alike.
3. Rubber. The chemistry of sulphur in rubber is studied. The opinion prevailed that the greatest market was the United States.
4. Matches. Note that paraffine has replaced sulphur and that only compounds of sulphur are used now in matches and none of the pure element. This is no longer a market then.
5. Compounds that are marketable which are made commercially from pure sulphur. Space will not permit the consideration of all of these but sulphur dioxide, sulphuric acid, and carbon disulphide are among those presented here.

III. Conclusion. The final answer to the question and the needed qualifications is decided upon by the class.

This outline is, of course, merely suggestive and could undoubtably be greatly improved upon. Probably many other questions would be more satisfactory to use in this type of work. "How was sufficient nitric acid obtained to prepare all the explosives needed in the world war?" and "Why is aluminum used so extensively?" have proved to be real interest getters. However, the problem used is typical and serves to illustrate the point.

In conclusion, then, we may say that there are three outstanding reasons for the occasional use of such problems; First, they vary the classroom procedure and thus maintain interest; second, they develop logical thinking on the part of the pupil; and finally, they demand more extensive reading and therefore more actual chemical information is gained.

ALASKA TEACHERS ACT AS HEALTH OFFICERS.

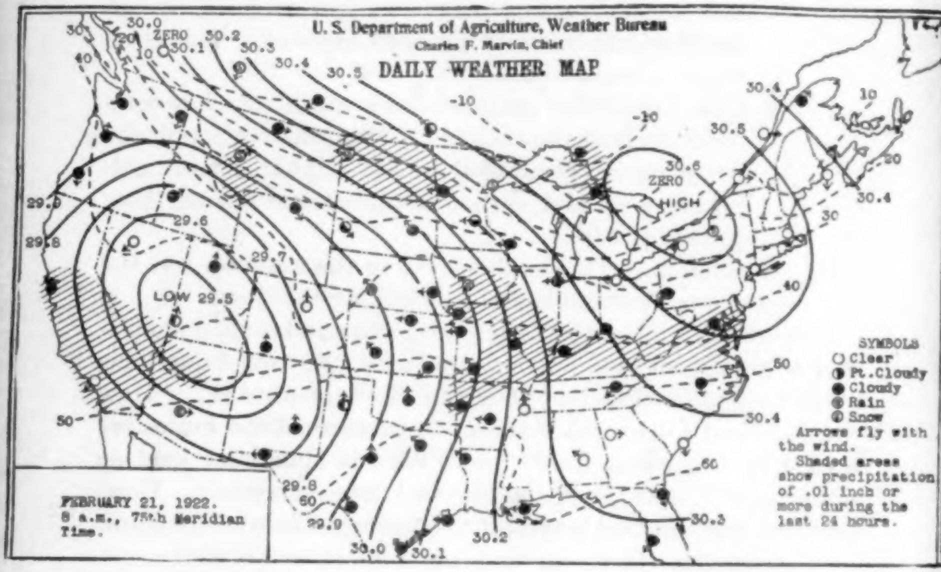
Employees of the Alaska Native School, Medical, and Reindeer Service are authorized to act as health officers when there is no local board of health in the vicinity. It is the duty of health officers to comply with the territorial rules and regulations, for the isolation and quarantine of contagious diseases, to report monthly, on blanks provided, all cases of contagious diseases occurring in their respective villages, and to comply with requests of the commissioner of health for Alaska.—[School Life

THE MOVEMENT OF A STORM AREA ACROSS THE UNITED STATES AND SOUTHERN CANADA[1].

By W. S. Belden, St. Joseph, Mo.

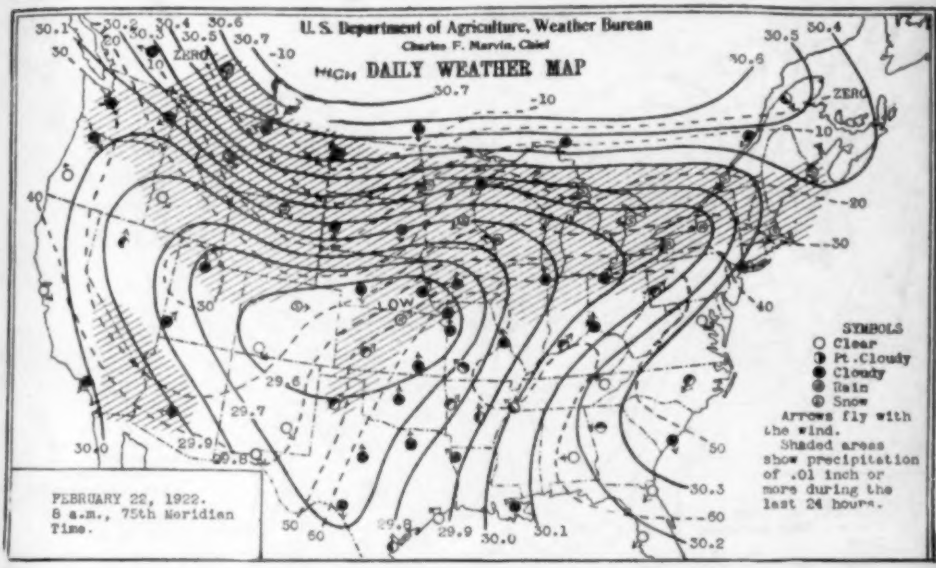
Meteorologist, U. S. Weather Bureau.

A bird's-eye view of weather conditions prevailing at the surface of the earth at the same hour on each of four consecutive mornings is portrayed in the accompanying series of weather maps covering the period from February 21 to 24, 1922. Conditions attending the progress of this storm area or cyclone, as shown by the maps, were in general, similar to conditions prevailing with scores of other storm areas that cross the United States annually, but its magnitude and intensity of development make its characteristic features stand out in a typical manner.



The changes preceding, accompanying, and following the eastward movement of this strongly developed storm area were extensive, and unusually well defined in districts east of the Rocky Mountains. The storm produced general precipitation in the middle and northern portions of the Rocky Mountain region, Plains States, and thence eastward to the Atlantic coast. Amounts were moderate to heavy over the winter wheat belt and ended a severe drouth of more than three months' duration in Oklahoma, Kansas, and Nebraska. Heavy snows, ranging from five to fifteen inches, and in a few places

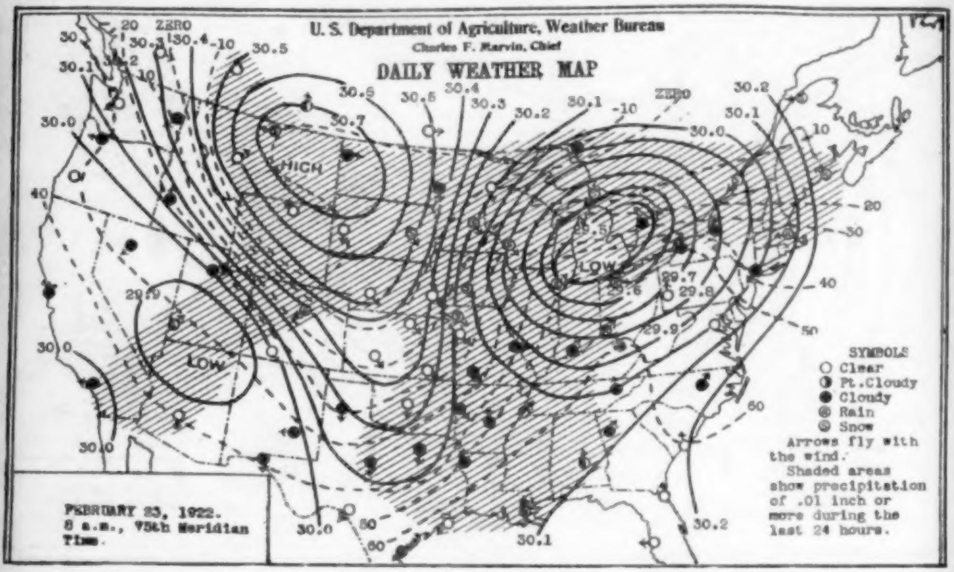
from fifteen to twenty-five inches, were reported in Upper Michigan and the northern portions of Wisconsin and Minnesota. In the middle portion of Lower Michigan from two to four inches of rain, freezing as it fell, formed a very heavy coating of ice on trees, wires, etc. The destruction to orchards, and telephone and telegraph lines, resulting from the weight of the ice, was unprecedented for that section. Thunderstorms occurred on the 22nd in the middle Missouri and upper Mississippi valleys and in the Lake region. The storm caused remarkably high winter temperature as far north as Michigan, and it was followed by a moderate cold wave. At Chicago the temperature rose on the 22nd to 68 degrees, which is the highest



February temperature ever recorded by the Weather Bureau at that station, the record covering a period of more than half a century. The cold wave that developed in Montana on the 22nd spread rapidly southeastward in the rear of the storm area, reaching almost to the Gulf coast by the morning of the 23rd, with a 24-hour fall in temperature of 20 to 50 degrees or more over a large territory, including the middle and southern Plains States, Iowa, Missouri, and western Illinois. During the 23rd it advanced eastward over the Ohio and lower Mississippi valleys, resulting in freezing temperature on the morning of the 24th southward to the Gulf States, while from ten to twenty below zero occurred in the Dakotas, Montana, and

northern Wyoming. The fall in temperature during the twenty-four hours ending at 8 a. m. on the 24th was from 20 to 40 degrees in Tennessee and northward over the Ohio Valley and Lake region, but with readings only slightly below the seasonal normal. The cold wave spent its force before reaching the Atlantic coast.

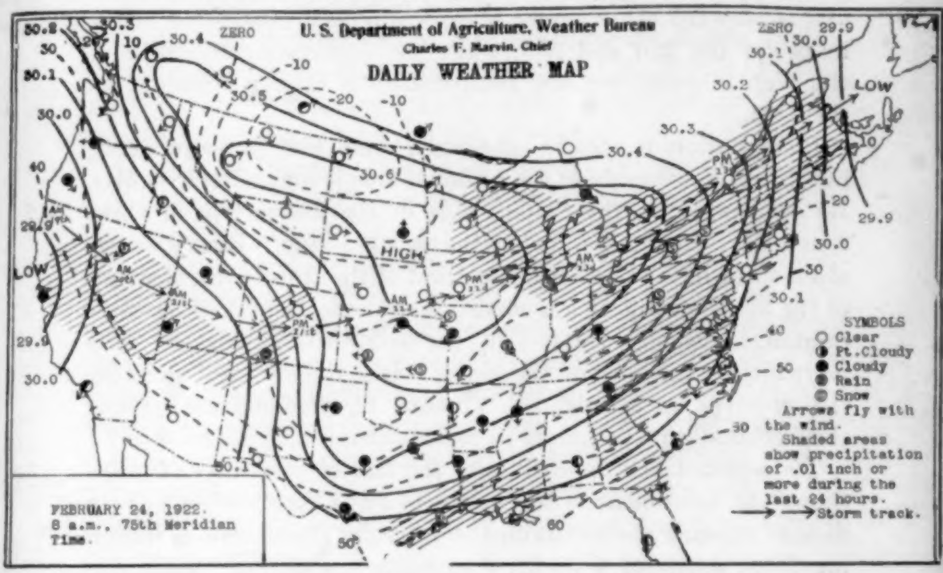
Following this general survey of weather conditions for the four-day period, let us note briefly some of the more important details of the maps and the movement of storm areas. The isobars, continuous lines, pass through points of equal air pressure and are drawn for each one-tenth of an inch of variation in barometric readings, reduced to sea level as a basis of com-



parison. Regions where barometric pressure is lowest are marked "Low" and regions where pressure is highest are marked "High." These lows and highs move eastward across the United States and southern Canada, the rate of advance being much greater in winter than in summer. The development of each is also more pronounced in winter than in summer. Lows may originate anywhere. Their paths vary in length from a few hundred miles to more than half of the circumference of the globe. They are usually classified with respect to the region in which they first make their appearance on the daily weather map. Considering all the lows shown on the daily weather map of Canada and the United States for a period of twenty

years, 38 per cent first appeared in the vicinity of Alberta, Canada; 15 per cent in the north Pacific coast region; 12 per cent in Colorado and vicinity; and the remaining 35 per cent in six other regions. Many of the lows that appear over Alberta on the map come from Alaska. The low shown on the accompanying maps belongs to the north Pacific type.

When the lows, occurring one after another, advance eastward along the Canadian border and over the Lake region, as they sometimes do in summer, they are generally attended by showers in the northern states, while dry weather may persist in the corn belt and to the southward. Lows coming from the southwest in winter and spring are usually good rain producers



and are generally the cause of spring floods in the lower and middle Mississippi and Ohio valleys. A strongly developed high that moves southeastward from Canada on the east side of the Rocky Mountains in winter, following in the rear of an energetic low, as shown on the map of the 23rd, produces a cold wave in the Missouri Valley and eastward. If the energetic low is farther south and advancing eastward over the Gulf states, the cold wave may be severe as far south as the Gulf coast.

In the northern hemisphere the wind blows spirally inward (counter clockwise) toward the center of the low, and spirally outward (clockwise) from the center of the high, except that in

mountainous regions topography may exert a modifying influence on the wind direction. The spiral movement of the wind is well illustrated in the maps. Steepness of barometric gradient determines the velocity of the wind. Strong winds were general in the northern and central portions of the United States on the 22d. As seen on the maps for the 22d and 24th a low or a high may cover the greater portion of the United States, the horizontal extent being perhaps a thousand times greater than the vertical thickness.

Isotherms, broken lines, pass through points of equal temperature and are drawn for each ten degrees of variation. The effect of the low in producing high temperature to the eastward and southward of its center is especially well illustrated in the maps for the 22d and 23d, while the dominating influence of the high in producing low temperature is clearly apparent on the 24th.

Precipitation is closely associated with low pressure areas, but its distribution about the center of lows is somewhat irregular. Its occurrence on the eastern side of the low is two or three times more frequent than on the western side. Heavy snows often occur in the northeast quadrant of the storm area, the map of the 22d showing such a condition, but the district of heaviest rainfall is usually located in the southeast quadrant. The more intense the low and the nearer it is to the source of moisture the greater, as a rule, the amount of precipitation. Clear skies generally predominate in regions covered by highs.

The storm track appearing on the last of the series of maps shows the movement of the storm to have been comparatively slow in crossing the mountains, consuming three days in traveling from northern California to eastern Colorado, while the distance from eastern Colorado to the mouth of the St. Lawrence River was covered in two days. As a rule, lows in the United States move south of east until they reach the Mississippi Valley and then to the northeastward, passing to sea off the coast of New England or to the northward.

(Copies of this article may be had for five cents a copy, 10 forty-five cents. Address the business manager.)

THE USE OF THE WEED-PATCH IN THE TEACHING OF HIGH SCHOOL BOTANY.

By Arthur Monrad Johnson,
University of Minnesota.

The successful teaching of botany in the high school depends primarily on preparation, which should include a reasonable familiarity with the vegetation of the locality and how to use it. There are roadsides, ditches, fields, gardens, woods, and copses all about us. Let us explore them. Let us gather from them the materials that we shall use in our class-work. The way we utilize these materials will have much to do with the results we hope to attain.

The remark is frequently heard to the effect that the locality offers little or nothing in the way of plants for study. It has always seemed to me that such a remark is a confession of ignorance. Those places are rare in which materials for an elementary course in botany are not to be had.

As the title suggests this paper aims to outline in a general way the uses to which a common weed-patch may be put in teaching high school botany. There are perhaps few schools, especially in rural communities, that can not boast of a weed-patch in proximity to the grounds. The problem will be what materials to get there and how to use them. It is not necessary that the sequence of topics be followed as here presented. The writer, in his own high school experience, made the practice of altering the sequence from year to year, always retaining, however, a systematic correlation of the subject-matter. It does not matter so much what we begin with as how we begin. But having begun we should strive to present a logical connection of subject-matter.

It would not be too bold a step if the class were taken out into the field on the first day—just to get away for once from the conventional routine of beginning in the laboratory. Perhaps it might stimulate the germination of the idea that the study of botany belongs properly out of doors. Arriving at the weed-patch we may, if we have no other definite plans, begin our studies by trying to find out how many different kinds of weeds grow there. This is, of course, an unusual departure from the ordinary formal way of beginning botany, but that does not matter; what we are going to try to do is to arouse an interest in our subject—we want action, and the class will be engaged in a healthful kind of activity, and the teacher,

too, in searching out the different kinds of weeds. We may find that there are more kinds of weeds there than we had thought—we have made a discovery, and discovery is the life of science. Lest some interpose the objection that this method teaches little of botany, as we have been accustomed to have it taught, we would hasten to explain that we are not for the moment concerned so much with orthodox content teaching as with the problem of arousing a certain interest in the science and of imparting certain lasting educational values. The data we obtain from this first study of the weed-patch may not seem of much importance, but the fact that we have taught the class to make, and to record, observations in the field is important, and if we now compare these data with similar data obtained from observations in other similar localities in the neighborhood we shall have an accumulation of facts of some significance—we shall at least learn something about the weed population of the community. We may extend our studies to a comparison of our data with similar data obtained from studies of home gardens.

Not the least important element in the method we have so far been discussing is the fact that we have also taught the class how to record their observations. In our opinion, nothing is of greater value in the educational process, especially as far as the sciences are concerned, as the inculcation of orderly habits of recording observations, facts, and whatever pertains to the problem in hand. This is the very foundation of the scientific method. It is one of the most important factors in commanding the respect of the student for the science. It is in this connection too that the student's notebook can claim its chief excuse for existence.

Our attention may next be directed to ascertaining what weeds are the most abundant. This exercise affords another opportunity to test the student's powers of observation. To carry out our observations in an orderly (and scientific) manner we may ascertain the number of individuals of each kind of weed growing within a definite area, as, for example, a square rod of ground. Our tabulated data may not agree, perhaps, with our estimate. Hence it will be our purpose to point out the relative value of exact data as opposed to estimates. It will be important also to let the class try to explain why some kinds of weeds are more abundant than others, per unit area, which will involve a study of the form ("growth-form") of the plant-body. We may further use "growth-form" as a basis

for grouping or classifying the weeds, and listing them accordingly, in this way introducing the subject of the classification of plants, a classification of the students' own making, from actual observation of the characters, and a classification which they will understand. It will be important to point out what is the basis of the classification, something which few students of taxonomy ever thoroughly grasp. There will be found among the weeds certain growth-forms known as "tumble-weeds," and the opportunity should be seized upon to show how the tumbling habit has been brought about and what rôle it plays in the dissemination of the seeds of the plant. A number of interesting and profitable studies suggest themselves here. The camera can be brought into service to great advantage in this connection. It might be of interest to determine the distance traveled by some of these tumble-weeds.

A certain amount of description will be required in the course of these studies. These descriptions may be in the form of drawings, or sketches, or in writing. Lest we fall into the error of regarding the drawing exercise as the sine qua non of botanical instruction let us consider the written exercise. It is just as important in the study of botany that the student acquire the habit of writing well as of drawing well; indeed, few individuals ever attain the latter objective in the brief spell they are under our instruction. The botanical laboratory is an opportune place in which to put into practice the principles of English composition and of rhetoric learned in the English department. It requires some ability on the part of the student to describe fairly intelligibly the growth-forms of the different weeds It will tax his vocabulary; but the acquisition of a vocabulary is a thing to be desired, in the study of the sciences, at least. By this it is not meant that the student shall express himself in "technical" phraseology: we mean that he shall learn to express himself, so that he may be understood, in simple English. "Scientific" expression will develop with experience in the science. A profitable hour or two may be spent in the laboratory in discussing the relative merits of the written exercises. By way of stimulating interest the best papers by students in the botany class on some botanical subject might find space in the school magazine. For fear again that we are not imparting sufficient orthodox botany for the time spent, we would interpose that we should not be in a hurry to get over ground. In our hurry to cover the content of prescribed courses of study

we too often neglect certain fundamentally important educational values that should be intimately linked with the study of botany. It should not be quantity instruction that we should strive after. We believe high school students are quick to sense the spirit and the thoroughness of a teacher's method.

Often we fail to teach clearly the distinction between essentials and nonessentials, differences and similarities, and often we dwell on the obscure to the neglect of the obvious. We neglect training in analysis, as we also neglect training in synthesis. If the class can write down clearly the principal differences and similarities between any two different species of weeds from the weed-patch it would demonstrate ability in analytical seeing. There is any amount of material in the weed-patch for training along the lines above indicated. To be keen of eye in the field is as important as to be keen of eye with the microscope. The danger is that our students shall not be taught to see at all. It is suggested, therefore, that written exercises describing the differences, and similar exercises describing the similarities between various species of the commonest and most familiar weeds will be profitable. In this connection it will be worth while also to point out, and to learn to recognize, those characters by which a weed may be distinguished from other weeds, "recognition marks" as we may call them. Then, too, there is the question whether the weed is an annual, a biennial, or a perennial. How can we tell? we will make an effort to find out by actual studies of the plants in the field, and in our notebooks we will list the weeds accordingly in separate columns, to which we will append a written discussion of the characteristics common to annuals, to biennials, and to perennials, and our reasons for the listing we have submitted. In the course of this investigation in the field we shall learn a good deal about root systems, stems, organs of storage of reserve foods, how plants prepare for winter, and how they are able to renew their growth on the return of spring, all suggesting a series of profitable field and laboratory studies that may be carried into the late autumn. The thoughtful teacher will see to it that the field and laboratory studies are properly correlated, so that the morphological, the physiological, and the ecological facts may be shown to have some connection. There is so much subject-matter connected with roots and stems represented in the weed-patch that we should not be in want of material for extended studies. There is material, as

suggested by the preceding studies, for the study of the different types of roots and of stems, of underground stems, of the relation of root systems to water supply, etc., etc. We know of nothing much better than the dead and dry stems of weeds in autumn for use in tracing the course of the fibrovascular bundles, and their arrangement; and for the study of nodes and internodes of aerial and underground stems, and of leaf arrangement, weeds are excellent material.

One of the most fascinating subjects for study in the autumn is that of fruit and seed dispersal. Here again the weed-patch is worth consideration. Quantity production of fruit and seed, size and weight, agents of and devices for dissemination, relative amount of germination of seeds in the autumn, etc., etc. are topics which at once suggest themselves, and are profitable because they have a bearing on the productive activities of the community. As an object-lesson on the economic relations of weeds we may make a series of studies of the relative purity of the various grain crops of the community (if in a rural community) from samples of grains obtained from threshers or from grain warehouses and elevators. From such studies the characteristics of the fruits and seeds of the various weeds are often quickly learned, and we may include here bulk characteristics as well as characteristics of the individual fruit and seed specimen. We shall also notice in the weed-patch that seeds of some of the weeds germinate and develop into good-sized seedlings before frost. It may be worth while to follow out observations on the effect of this autumn germination on the weed population next spring, whether or not the seedlings are killed by frost or are able to resume their growth the following spring. But these weed seedlings are useful also for the study of seedlings as such, and can be used for this purpose just as well as the seedlings of the bean, pea, etc., or by way of comparison with the two last named. The characteristics of the seedlings of many of the weeds can be learned by sowing their seeds in the laboratory. This suggests a number of studies on germination and development of the seedling.

Much more could be said about the weed-patch as an object of study in a course in elementary botany, which can be made to include the provinces of morphology, physiology, and the always fascinating one of ecology, but the above will suffice to indicate what we would like to emphasize, namely, that it is not necessary to cling to the text-book as regards materials

and method, for plants are everywhere about us; all we need do is study them and apply them to our work.

For a number of years the writer has made the practice of taking his classes of teacher candidates out into a spot of waste ground close by our botanical laboratories for the purpose of studying its possibilities as a source of materials for a course of study in high school botany. On our first visit we usually make a list of all the species growing there—trees, shrubs, herbs (including weeds and grasses). We next make a study of the characteristics of some of the commonest and best known species (e. g. weeds, for convenience) and their suitableness for showing certain facts of morphology, or for demonstrating certain principles of physiology or of ecology. A period of two weeks can be spent with profit in the preparation of a course of study from the materials growing in a spot of this kind. During the present autumn we listed some fifty species, including some bryophytes and fungi—an abundance of material for an elementary course. Our problem now is to formulate a correlated course of study based on these materials, assuming that we have no text-book and only very limited laboratory facilities. The enthusiasm with which these prospective teachers have attacked the problem augurs well for their success as teachers of botany.

EVENING SCHOOL.

Do you know what the public schools are doing for adults?

Six hundred cities in the country are offering one or more courses in public night schools for the very purpose of your advancement.

Is your city one of these? If so, are you making the most of your opportunity by regularly attending the same?

Nineteen thousand trained men and women are employed as instructors and 600,000 men and women are enrolled in these public night schools.

Get in touch with the superintendent of schools in your city at once and learn what opportunity there may be for you to enroll in one or more courses.

Many private schools, universities, and college also offer night courses, many of which lead to degrees.

In this way the man and the woman employed during the day may continue their education and find pleasant as well as profitable employment for their evening hours.

A bachelor living in a rural community objected to paying taxes for the support of a modern consolidated school. He wrote a letter to the local paper saying that the old school was good enough. A mother wrote a reply, in which she said, among other things: "I wonder whether he lives in a log house, wears homespun, cooks by a fireplace, reads by a tallow dip, works an ox team, or rides to church in a lumber wagon! I wonder!"

THE STUDY OF MATHEMATICS UNDER THE INDIVIDUAL SYSTEM.

By Mary M. Reese,

Skokie School, Winnetka, Ill.

About three years ago the system of individual instruction was introduced in the Winnetka schools by Mr. Washburne, our superintendent.

This naturally had to be done gradually for, after establishing definite goals for the work which must be accomplished in each grade, the material had to be prepared very carefully so that it would be as nearly self-instructive as possible and the children could use it with a minimum amount of help from the teacher. Under this system a child progresses at his own rate of speed, neither being held back by slower pupils nor forced to go forward too rapidly for thorough understanding.

There is no subject, I believe, where there is such a difference in ability among pupils as in mathematics. Under the class instruction, many times children have reached the intermediate school with inadequate foundation in fundamentals because they were slow to grasp at least some process but had to progress with the class.

Under the individual system a child cannot fail. He never repeats a grade although he may take more than a year to cover the work of a grade but the next year he commences where he left off. This time may be made up later if he has a good foundation. On the other hand many children are able to accomplish the year's work in less than the given time and if so are promoted to the work of the next grade in that subject at once, but they never skip a grade. A child does not change rooms each time he is promoted, the groups being changed usually once a year.

The arithmetic in all grades contains much practice work with answers so that the child can test himself. The preparation of these practice books has naturally been a big test. This has been done by all the teachers who are to use the books, their work being mimeographed and assembled into books which are given to the pupils as they need them. The work had to be taken up step by step with a quantity of practice work for each step. Each book is provided with answer sheets so that each child can correct his own work. Each lesson is followed by tests corresponding with the work taken up in the lesson.

In the lower grades some of the development must be done

orally but most of this work has been planned so that the children can understand it with a minimum amount of oral instruction. In the upper grades all of the work is developed in their practice books. If this is not understood by a pupil he has an opportunity to ask for further assistance. When he feels he is ready, he takes a test on the new step. This test is corrected by the teacher.

In the intermediate school, if he makes any error in his test he corrects mistakes, takes more practice work if his test shows need of it, and takes a second test and if necessary a third test.

There is necessarily some bookkeeping in connection with this work so that a teacher may know at any time where each pupil stands but usually only a record is kept of correct tests.

On the other hand all the practice work is corrected by the children themselves and not every child hands in tests every day, making fewer papers for the teacher to correct than under the class system. At the end of the month a goal book is sent home for parents' inspection and signature. This book contains a list of all the goals which must be reached for that grade, and shows how far the child has progressed toward the achievement of these goals. If he is promoted in any subject he is given the goal book for the next higher grade.

The arithmetic pages of the seventh and eighth grades are given below. On the fundamental page, "speed" means the number of examples of standard difficulty worked in three minutes; "accuracy" is the per cent correct.

In the seventh grade, the required work is divided into two parts; the first includes application of percentage such as profit and loss, discount, commission and interest, and the second part is work in mensuration. In this section of required work are the subjects in mensuration which are essential to all children, even if they leave school at the minimum age.

Seventh Grade Arithmetic Goals.

Explanation:

In the Seventh Grade, Parts I and II are essential for promotion to Grade 8 in Arithmetic. This is in addition to work in fundamentals, the goals of which are given on the preceding page. The advanced part is to be completed as far as possible.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mch.	Apr.	May	June
Self-Reliance									
Diligence									
Deportment									

SEVENTH GRADE, ARITHMETIC FUNDAMENTALS—GOALS.

Addition Review	Sp. 6 Acc. 100 per cent		
Subtraction Review	Sp. 12 Acc. 100 per cent		
Simple Multiplication	Sp. 3 Acc. 100 per cent		
Compound Multiplication	Sp. 5 Acc. 100 per cent		
Long Division	Sp. 2 Acc. 100 per cent		
Fractions	Sp. 4 Acc. 100 per cent		
Decimals	Sp. 4 Acc. 100 per cent		

Course Begun.............................192......

Promoted to Grade 8 Arithmetic Fundamentals....................192..........

....,
Teacher.

SEVENTH GRADE ARITHMETIC GOALS.

Part I—Percentage Application	
1. Percentage Review	
2. Profit and Loss	
a. Finding Gain: Cost and rate given—Test 1	
Test 2	
b. Finding Loss: Cost and rate given—Test 3	
c. Finding per cent of Profit or loss—Test 4	
Test 5	
3. Commission	
4. Discounts	
5. Interest and Amt. for years—Test 8	
6. Interest and Amount for yr. and mo.—Test 9	
Review Test	
Part II—Mensuration	
1. Review of Long Measure—Test 1	
2. Square Measure—An acre of land—Test 2	
3. Volume of Rectangular Prism	
Test 3	
Test 4	
Test 5	

4. Circles	
Comparison of Diameter, Radius, and Circumference—Test 6	
Test 7	
Test 8	
Test 9	
Test 10	
Review Test	

Completed..........................192....

Advanced

Area of Triangle—Test 1	
Area of Circles—Test 2	
Volume of Cylinders—Test 3	
Short Cuts in Multiplication	
Test 4	
Test 5	
Test 6	
Short Cuts in Division	
Test 7	
Test 8	

Course Begun.............................192.......

Promoted to Grade 8 Arithmetic......................192..........,

....
Teacher.

In addition to the required work mentioned above, a general review of all fundamental operations is required. To receive an O. K. in any operation the pupil has to work accurately a given number of problems in three minutes. If he makes any

EIGHTH GRADE ARITHMETIC GOALS.

I. BUSINESS FORMS		2. Stock	
1. Bills		3. Bonds	
2. Receipts		Review—Factoring	
3. Cash Accounts		*II. ADVANCED*	
Banking			
1. Checking Accounts		1. Square Root—Test 1	
2. Savings Accounts		Test 2	
		Test 3	
Real Estate		Test 4	
1. Buying and Leasing		Test 5	
2. Mortgages and Notes			
3. Bank Discount		2. Hypotenuse of Right Triangles	
Insurance			
1. Fire Insurance		3. Use of the Formula—Test 1	
2. Life Insurance		Test 2	
Taxes		Test 3	
1. Local Taxes			
2. National Taxes		4. Use of the Equation—Test 1	
Stocks and Bonds		Test 2	
1. Organization of corporation		Test 3	
		Test 4	

Date Begun..192........

Work Completed....................................192........,

....

Teacher.

error, he has to take additional practice work and tests until the required goal is obtained.

The individual work covers the minimum amount of work which must be accomplished for promotion to a higher grade but there is much social work done in all the grades. This work supplies the life and the co-operation among the pupils that is lacking to a certain extent in their individual work. As arithmetic is more of a drill subject and more easily adapted to individual work those other subjects, much of the social work is found in other studies. From one-third to one-half of the pupils' time is occupied by this social work which is an important part of their curriculum; although their marks and promotions are based entirely on their individual work.

In the eighth grade, however, the work although outlined for individual work and followed by tests on the essential points for which each one is held responsible is mostly developed by discussions or by some form of social work. The required work in this grade is composed mostly of business subjects. The topics themselves are more important than the examples usually presented in connection with them. How many of us ever learned

very much about insurance, taxes, stocks and bonds from the numerous examples we worked? It is our aim in the eighth grade so to vitalize these subjects that they have a real meaning to the boys and girls. Not that they will have a comprehensive knowledge of business, but they will get enough to lay a foundation for more as the needs arise and to have an understanding of business terms which they will hear and of which they will read.

The children are taught banking by running an imaginary bank. They all receive check books which are printed in the school print shop by the boys and, following directions found in their practice books, they make out checks to one another and fill out the stubs in their books. The checks received are endorsed according to directions and with deposit slips made out are deposited in the bank, the children taking turns as tellers. If any error is made the check has to be rewritten. After all the required checks are written correctly and deposited, they balance their accounts and take a test which covers the essentials. If a mistake is made they take a second test.

They have studied stocks and bonds by forming a stock company. They appointed incorporators who, after deciding on the amount of capital stock and the cost a share, solicited stock from other members of the class, which was paid for by check. Meetings were held at which directors and officers were elected and the subject studied learning the meaning of preferred and common stock and other important terms used. At the end of the first imaginary year dividends were declared, the children receiving their dividends in checks made out by treasurer. The corporation then borrowed money by issuing bonds.

This year the plan was changed somewhat. A real corporation was formed with capital stock amounting to $300, the incorporators selling shares of preferred stock yielding seven per cent interest at ten cents a share in lots of from one to fifty shares, not only to the eighth grade but to lower grades, parents, and teachers. Up-to-date about $150 has been paid into the treasury by subscribers who have received regular certificates with the seal of the corporation. At the end of the first month, business being prosperous, a quarterly dividend of two per cent was declared, each stockholder, holding five or more shares, receiving his pennies from the treasurer.

This company, known as the Skokie Finance Corporation, has under its control the school paper which is edited and printed

by the boys in the school shop. It also runs a very active schoo' store which sells school supplies to the pupils. It expects to control other enterprises that arise. All bills are paid by checks made out by the treasurer and countersigned by either a manual training or a mathematics teacher.

The store is operated by children who are so far advanced in their work that they have extra time. These children are taught simple accounting and are keeping a set of books in connection with this work.

Next year we hope to continue this work, issuing bonds and enlarging its usefulness.

In addition to the essentials which must be achieved by the child, in both the seventh and eighth grade, an advanced course in mathematics is prepared for those who finish the essential part of the work before the close of the year. This is entirely individual and the child works as far as he individually is able. As the essential part is expected of the slowest, the majority will do some of the advanced work and many finish all of it. As the eighth grade advanced work is designed as a help to high school mathematics, the children are urged to work as much as possible of this if they are up to standard in their other studies.

The attempt has been made to fit the work to the needs of the children and not fit the children to the course prepared.

THIRD LIST OF MARGINAL NOTES ON CAJORI'S HISTORY OF MATHEMATICS.

By G. A. Miller.

University of Illinois.

Two lists of marginal notes on the second edition of Cajori's *History of Mathematics*, 1919, were published in volumes 19 and 20, pages 830 and 300 respectively, of this journal. Having given a critical course, based on this edition, during the recent Summer Session of the University of Illinois, we naturally noticed a considerable number of additional places where it seemed to us that modifications should be suggested. Some of these modifications related to questions of such a fundamental nature that it seemed impossible to bring out their real significance in brief marginal notes, but a considerable number of them can be either completely stated or sufficiently outlined in such notes, and hence they appear in the list which follows.

Page VII, line 27. Instead of Vieta and Descartes read Vieta to Descartes. In fact, the work of Vieta is treated in

the preceding section while that of Descartes appears in the following section so that even the suggested modified form is not entirely satisfactory, but it would be an improvement. Page VIII, line 15. Instead of 316 write 366.

Page 1, line 9. This reference to "the arithmetic of the Hindus" seems to be a remnant of a discredited view. Cf. *La geométrie grecque*, by Paul Tannery, 1887, page 5. Various other statements made by Cajori admit a similar interpretation. The mathematical contributions of the Hindus are often exagerated

Page 5. The various references, here and elsewhere, to the sexagesimal system of the Babylonians would become clearer if it were stated that we have no evidence that a purely sexagesimal system of numerical notations existed in any country. Such a system, like our ordinary decimal system, would imply distinct independent symbols for all numbers less than the base of the system.

Page 7, line 6. Should the abacus be called the most improved aid to calculation? The question might be raised why our merchants do not generally use it even when they use no other instruments as aids to calculation.

Page 9, line 10. It is here stated that "all Greek writers are unanimous in ascribing, without envy, to Egypt the priority of invention in the mathematical sciences." On page 32 of volume 2, second edition, Cantor's *Vorlesungen über Geschichte der Mathematik*, it is stated that Theon of Smyrna had said that in the study of the movements of planets the Egyptians used constructive methods while the Chaldeans preferred to calculate, and that the Greek astronomers had obtained the beginnings of their knowledge from these two nations. On page 6 Cajori states that Iamblichus attributed to the people in the Tigro-Euphrates basin the invention of the so-called *musical proportion*.

Page 10, line 12. According to Heath, *A History of Greek Mathematics*, 1921, volume 1, page 123, we do not know that Ahmes made an error in finding the area of this triangle. We also do not know that the Eudemian Summary is an abstract from the work of Eudemus as stated near the bottom of page 15. Cf. Heath, l. c. page 118.

Page 11, line 9. Instead of "axioms and postulates" read axioms or postulates. In modern research as regards the principles of geometry no importance is attached to the difference between axioms and postulates.

Page 18, line 4. It is here stated, that the Pythagoreans were "forbidden to divulge the discoveries and doctrines of their school." A somewhat similar statement appears on page 80, line 9. In volume 1, page 66, of Heath, l. c., we are told that, at all events, the pledge of secrecy did not apply to their mathematics or their physics.

Page 23, line 16. There is no such *last polygon* inscribed.

Page 26 near bottom. The statement, "one of the greatest achievements of Plato and his school is the invention of *analysis* as a method of proof" should be compared with the following: "it may therefore well be that the idea that Plato discovered the method of analysis is due to a misapprehension." Heath, l. c., vol. 1, page 291.

Page 31, near bottom. The use of the term postulate should be compared with that found on page 2, line 6; and the distinction between the terms axiom and postulate as given near the top of page 32 should be conpared with the use of the former term on page 302, for instance.

Page 41, about middle. The theory of conic sections did not originate with Archimedes and Apollonius. In fact, on page 33 it is stated that Euclid wrote a conic sections, in four books, "which are the foundation of a work on the same subject by Apollonius." The statement that Apollonius "did not discover the focus of a parabola" should be compared with the following: "It is certain that Apollonius was aware that an ellipse has the property of reflecting all rays through one focus to the other focus. Nor is it likely that the corresponding property of a parabola with reference to rays parallel to the axis was unknown to Apollonius." Heath, l. c., volume 2, page 200.

Page 43, about middle. Our author speaks here of Heron the Elder and of Heron the Younger. In the Index we find the latter but not the former of these terms. In fact, near the bottom of page 43 it is stated that "no reliable evidence has been found that there actually existed a second mathematician by the name of Heron."

Page 48, line 10. The statement that "it appears that Simplicius brought forward a proof of the 5th postulate" should be modified since this postulate cannot be proved without making assumptions not given as postulates or axioms by Euclid.

Page 50, about middle. The statement, "It is worth noticing that it was **Pappus** who first found the focus of a parabola"

should be compared with our note on page 41, as well as with note 115 in the *Encyclopédie des Sciences Mathématiques*, tome 3, volume 3, page 50.

Page 52, near bottom. It is here stated that the change from the Herodianic signs to the alphabetic numerals was decidedly for the worse, while some mathematical historians have expressed the opposite view. Cf. Heath, l. c., vol. 1, page 38.

Page 56, line 14. These definitions of excessive and defective numbers are the opposite of those found in Heath, l. c., vol. 1, page 74. For instance, the number 8 is an excessive number according to Cajori while it is deficient according to Heath and others. This correction is the more important since it applies also to at least each of the first five editions of *A Short Account of the History of Mathematics* by W. W. R. Ball.

Page 59, about middle. The statement, "Hippolytus, who appears to have been bishop at Portus Romae in Italy in the early part of the third century, must be mentioned for the giving of proofs by casting out the 9's and 7's," should be compared with a similar statement on page 91, and with an opposite statement on page 337 of volume 1, Dickson, *History of the Theory of Numbers*, 1919.

Page 60, near bottom. It is not known that the work of Ahmes contains the first suggestion of the solution of equations. In fact, on page 13 it is stated that there exist other papyri of the same period which contain examples of quadratic equations and their solution, while the work of Ahmes contains only linear equations.

Page 68, near bottom. Instead of 1816 write 1916.

Page 72, line 8. This equation is not quite accurate. Cf. *Development of Mathematics in China and Japan* by Yoshio Mikami, 1912, page 24.

Page 77, near bottom. It is not known that magic squares originated in China. Cf. *Encyclopédie des Sciences Mathématiques*, tome 1, volume 3, page 63.

Page 80, line 30. Since $4(n+1)^2$ is equal to the square of every even number except 2 when n assumes the different values of natural numbers it would not be necessary to add the number $16n^2$. In line 35, the words "can have the same ratio" should be replaced by can be consistent. This condition is necessary but not sufficient.

Page 83, line 23. It is questionable whether there were any really "great Hindu mathematicians." In comparison with the

work of Archimedes or Apollonius the work of these Hindu mathematicians was insignificant. In view of the emphasis which the Pythagoreans placed on number it is questionable whether one should say that "the Hindu dealt with number the Greek with form," although similar statements are found elsewhere. The following quotation from the *Encyklopädie der Mathematischen Wissenschaften* Band 3, page 773, throws light on this point. "The *Elements* of Euclid have undisputedly been regarded as the foundation of the mathematical science since ancient times, and they have denoted the concept and the extent of elementary mathematics."

Page 85, near bottom. The statement, "a knowledge of the Pythagorean theorem is disclosed in such relations as $3^2+4^2 = 5^2$, $12^2+16^2 = 20^2$, $15^2+36^2 = 39^2$," is apt to be understood as meaning that the Pythagorean theorem was known at the time when such relations were discovered, or immediately thereafter. Such an inference is clearly not justifiable.

Page 86, line 6. Instead of "relation of the diagonal to a square" read ratio of the diagonal to the side of a square.

Page 87, about the middle of this page, it is stated that Aryabhata gives in one place a very accurate value of π, and a little lower it is stated that when the radius of a circle is 100 the perimeter of a regular inscribed polygon of 384 sides gives the value which Aryabhata used for π.

Page 92, near bottom. The sentence, "It may here be added that chess, the profoundest of all games, had its origin in India," should be compared with the following statements found on page 100, volume 6, of the eleventh edition of the *Encyclopedia Britannica:* "The origin of chess is lost in obscurity. Its invention has been variously ascribed to the Greeks, Romans, Babylonians, Hindus, Arancanians, Castilians, Irish and Welch." On page 424 of volume 6 of *The Americana*, 1918, we find the following: "it is probable that it originated in China and passed into India." It is remarkable that the wild sentence quoted at the beginning of this paragraph is also found in the first edition of Cajori's history, page 92, and that the quarter of a century which elapsed between these two editions did not suffice to eliminate such an obvious inaccuracy.

Page 93, near bottom. The assertion that the Hindus never discerned the dividing line between numbers and magnitudes raises the question whether there is such a line.

Page 94, line 2. This antiquated quotation from Hankel should be compared with the *Encyclopédie des Sciences Mathématiques,* tome 1, volume 1, pages 137 and 138.

Page 96, line 1. The statement that "doubtless this cyclic method constitutes the greatest invention in the theory of numbers before the time of Lagrange" is clearly an exaggeration. The Euclidean algorithm is certainly more important.

Page 101, line 21. An Arabian patron of learning, Caliph Al-Mamun (813-833) is mentioned here and on the following page but his name does not appear in the Index. The two numbers appearing after a name and inclosed in parenthesis usually signify the years of birth and death respectively. In the present case, however, they seem to signify the years of the beginning and termination of office, although in Poggendorff's *Handwörterbuch* it is stated that he became caliph in 814.

Page 106, near bottom. The statement that Al-Kaikhi was the first to operate with higher roots raises the question what is meant by higher roots. It is well known that Diophantus considered at a much earlier date roots of equations whose degree is as high as 6.

Page 107, near bottom. Instead of "the roots of" read a real root of Menaechmus did not construct the imaginary roots.

Page 108, near bottom. It is difficult to see what the sentence, "The last Oriental writer was Beha-Eddin (1547-1622)", is intended to mean. The natural inference would be that the Arabs of the Orient ceased to write on mathematical subject in 1622, but this is evidently untenable. Cf. *A History of Arabic Literature.* By C. Huart (1903), page 427.

Page 116, line 23. It is not certain that Berlinus was a pupil of Gerbert. Cf. *Encyclopédie des Sciences Mathématiques,* Tribune publique, No. 47.

Page 117, line 3. The statement "Gerbert's rules for division are the oldest extant" may be compared with a method of division described by Theon. *A History of Greek Mathematics.* By Sir Thomas Heath, volume 1, 1921, page 59. The reference to the adjoining figure in line 9 is not clearly stated.

Page 119, line 30. The sentence "Through Gerard of Cremona the term *sinus* was introduced into trigonometry" should be compared with the following, found on page 105, line 4: "Out of this translation sprang the word *sinus* as the name of a trigonometric function."

Page 121, line 14. As regards the name Zephirum cf. *Encyclo-*

pédie des Sciences Mathématiques, Tribune publiques, Nos. 4 and 8.

Page 123, line 7. Instead of "nor" read not.

Page 124, line 19. Instead of saying, "As yet cubic equations had not been solved algebraically," it should be said that the general cubic equation had not yet been solved algebraically. Special cubic equations had been thus solved by Diophantus and others.

Page 126, line 3. Instead of τ^3 write x^4.

Page 131, line 21. The sentence "For the first great contributions to mathematics we must therefore look to Italy and Germany" seems to refer to the contributions since 1453. The contributions of the Italian mathematicians, Ferro, Tartaglia, Cardan and Ferrari, relating to the algebraic solution of the general cubic and biquadratic equations stand out very prominently in the first half of the sixteenth century, but it seems questionable whether Germany had any men whose mathematical work is more important than that of the Frenchmen, A. Chuquet and F. Vieta. It is evident that there may be differences of opinion as to what contributions should be regarded as great.

Page 136, line 18. To the reader, who is familiar with the modern theory of equations, the following sentence is likely to appear to be silly: "Since no solution by radicals of equations of higher degrees could be found, there remained nothing else to be done than the devising of processes by which the real roots of numerical equations could be found by approximation." The study of the conditions which are necessary and sufficient that an equation can be solved by radicals and the study of functions by which general equations of higher degree can be solved have been very significant in the history of mathematics.

Page 138, near bottom. The relations between the letters m, n and a, b should have been noted.

Page 141, line 32. It is somewhat difficult to see why the epicycloid is here called a new curve since it is stated a little later that the idea of such a curve is at least as old as Hipparchus. The sentence beginning with "unlike" a little lower on this page seems to express an incorrect view.

Page 143, line 20. Replace 1580 by 1581.

Page 146, near bottom. Since Recorde died in 1550, it is not clear what is meant by the sentence "After Recorde the higher branches of mathematics began to be studied" in Great Britain. We are told on page 127 that trigonometry was studied earlier.

Page 150, line 18. It is here stated that the notion of a base never suggested itself to Napier while on the following page it is stated that the invention of the Briggian Logarithms occurred to Briggs and Napier independently. These relate to the base 10.

Page 163, near bottom. The sentence, "About twenty years earlier, Kepler had first observed that the increment of a variable, as, for instance, the ordinate of a curve, is evanescent for values very near a maximum or a minimum value of the variable," should be compared with the following statement: To Oresme's eyes the truth of the theorem, which 300 years later was embodied in the words, at the highest and the lowest points of a curve the differential quotient of the ordinate with respect to the obscissa is zero, revealed itself. Cantor, *Vorlesungen über Geschichte der Mathematik,* volume 2, second edition, page 132.

Page 172, line 20. Since Galileo lived before the time of Dedekind and Georg Cantor his keenness of vision and originality must have been *equalled* before this time. A thing is equal to itself.

Page 173, near bottom. The statement that in 1625 Descartes ceased to devote himself to pure mathematics should be compared with a statement on the following page to the effect that 12 years later he published his *Géométrie* upon which the claims that he is the founder of analytic geometry are based. It should also be noted that he said that all his physics is nothing else than geometry, and that geometry is commonly classed with pure mathematics.

Page 175, about middle. It is not correct to say that earlier publications contain only occasional references to the y-axis since Euler's *Introductio in analysin* was published two years earlier. Cf. *Encyclopédie des Sciences Mathématiques,* tome 3, volume 3, page 17.

Page 176, near bottom. It would be difficult to present a subject in a more obscure manner than is done in the last paragraph on this page.

As the Calculus with general quantities is commonly called Algebra, the example given near the top of this page should be modified.

Page 178, near bottom. It is fortunate that Wallis did not write $a^{2/3}$ for $\sqrt{a^3}$. We do not do this now. The statement that Newton first used negative and fractional exponents is apt to be misunderstood unless it is compared with the fractional

exponents used earlier by Oresme, see page 127, and the negative exponents used by Chuquet, mentioned on page 178. A little lower on this page write 1657 in place of 1659. Cf. *Encyclopédie des Sciences Mathématiques,* tome 1, volume 2, page 1.

Page 185, line 17. There is no ratio between a curve and the area of a parallelogram.

Page 187, near bottom. Here we find the form Stevinus, while the form Stevin appears elsewhere.

Page 189, near bottom. This integral is inaccurate.

Page 190, near bottom. The statement that "we must look to other countries than France for great scientific men of the latter part of the seventeenth century" is apt to mislead the reader unless he recalls that France had then the well-known mathematicians Rolle (1652-1719), L'Hopital (1661-1704), and Varignon (1654-1722). All of these are mentioned in the list of mathematicians which appears on page 204 of volume 3 of the *Taschenbuch für Mathematiker und Physiker,* 1913, while only one of the three noted foreign mathematicians and astronomers whom Cajori names as adorning the court of Louis XIV, is thus mentioned.

Page 196, line 13. It is here stated "that in the *Method of Fluxions* (as well as in his *De Analysi* and all earlier papers) the method employed by Newton is strictly infinitesimal," while on page 27 of volume 11 of the *Mathematical Gazette* it is noted that "there is in it no idea of an infinitesimal."

Page 204, near bottom. It is here stated that Newton invented the reflecting telescope while in the eleventh edition of the *Britannica* under Telescope it is said that Newton was the first to *construct* a reflecting telescope, but that Gregory proposed at an earlier date the form of telescope which bears his name.

Page 205, line 14. We do not know that Leibniz was an *independent* inventor of the calculus. Cf. *Encyclopédie des Sciences Mathématiques,* tome 2, vol., 1, page 247.

Page 209, near bottom. In view of the fact that the actual title of the other periodicals mentioned here is given one may ask why this was not done as regards "the literary and scientific review published in Germany". The term vertex in line 13 should have been defined, or curve replaced by conic section.

Page 211, line 28. Instead of 1694 write 1692. Consequently the following line should be changed.

Page 214, near middle. We find here and elsewhere in the

text C. J. Gerhardt, while in the Index the initials C. I. appear.

Page 220, line 6. It is difficult to see what is meant by the statement that "Robins deserves credit for rejecting all infinitely small quantities" since such quantities are not rejected in the best modern works on analysis.

Page 226, near middle. This theorem attributed to Cotes is meaningless as here stated. The claim made near the bottom of this page that Brook Taylor is the *inventor* of the branch of mathematics now called finite differences should be compared with the *Encyclopédie des Sciences Mathématiques* tome 1, volume 4, page 48. The date 1715-1717 should be replaced by 1715.

Page 231, near middle. The statement that "mathematical studies among the English and German people had sunk to the lowest ebb," during the period from 1730 to 1820, should be compared with the statement on page 247, "John Landen (1719-1790) was an English mathematician whose writings served as the starting-point of investigations by L. Euler, J. Lagrange, and A. M. Legendre," and also with the account of J. H. Lambert's work on page 245.

Page 233, line 6. The assertion that Frederick the Great was no admirer of mathematicians should be compared with the statement on page 253 that he held Lagrange in high esteem, and with other statements on this page and on page 242.

Page 235, line 18. In view of the fact that solutions of the equation $x^2+y^2 = z^2$ received so much attention on the part of ancient mathematicians, the reader is apt to be misled by the statement that Euler was the first to discuss the equation of the second degree in three variables. Euler gave a geometrical discussion.

Page 249, line 10. As this relates to a very important historical question it may be noted that the word limit does not appear in the quotation to which reference is given.

Page 252, line 27. Write face instead of "phase."

Page 265, near bottom. The sentence, "The general idea of decimal subdivision was obtained from a work of Thomas Williams, London, 1788" is somewhat vague. A similar statement appeared in the first two editions of Ball's *History of Mathematics* but was omitted from the later editions. The suspicion aroused by this omission is increased by Cajori's statements on page 148 in regard to the work of Simon Stevin. In particular, it is here stated that "Stevin was enthusiastic

not only over decimal fractions but also over the decimal division of weights and measures. He considered it the duty of the governments to establish the latter. He advocated the decimal subdivision of the degree." In view of these and other well-known facts the natural meaning of the sentence quoted at the beginning of this paragraph conveys a very inaccurate impression and it seems creditable to Ball that he omitted this quotation from the later editions and discreditable to Cajori that he incorporated it in his first edition even after this omission by Ball, and that a quarter of a century later he retained it in the second edition.

Page 266, near bottom. The statement that for forty years Legendre was the only one to cultivate elliptic functions should be compared with remarks in the *Encyklopädie der Mathematischen Wissenschaften*, Band II, page 196, where reference is made to the work on this subject by Gauss within this period of forty years.

Page 269, near bottom. Write 1829 instead of 1835. Cf. page 363.

Page 270, line 6. Instead of "largest negative coefficient" write the absolute value of a negative coefficient which has a largest absolute value. Instead of $P \div S + 1$ write $1 + P/S$ in line 8. The remarks near the bottom of this page in regard to any arbitrary function require modification.

Page 277, line 4. It is misleading to say that Stewart and Maclaurin were the only prominent mathematicians in Great Britain during the eighteenth century. Cajori gives a number of references to T. Simpson, J. Stirling, A. De Moivre, and others who made mathematical contributions during this century.

Some of these notes are due to suggestions on the part of members of the class. In fact, only a small part of such suggestions are here reproduced since it seemed desirable to give only those which appeared to be of general interest. The suggestions relating to the latter part of the book were omitted entirely since the list had grown too long already when this part was reached. Those who are interested in the mathematical developments of the nineteenth and twentieth centuries will usually be in better position to detect errors than those who are mainly interested in the earlier developments, and hence it seemed less useful to give here marginal notes relating to the former developments. The writer hopes that these notes may be especially helpful to those teachers who will use the work in question as a

textbook in a course on the history of our subject. Even those teachers who do not regard it desirable to cultivate a critical attitude towards the textbook on the part of students may find in some of these notes and the references involved therein additional information of unusual interest relating to the subjects under consideration.

THE PUPILS' ARITHMETIC RECORD.

By Rufus M. Reed,

Laura, Ky.

In teaching arithmetic in the upper grades, I let each pupil do individual work as far as possible, and keep his own record of his progress. I find the plan works to great advantage.

I have each pupil provide himself (or herself) at the first of the school with a suitable book in which to keep all the important problems which he solves each day. A book on the order of a small-sized ledger is suitable. I then have each pupil enter his (or her) name, grade, etc., on the first page, as follows:

"Thelma Blake, age 12. Sixth grade.

"Arithmetic Record for 1922, beginning with common fractions, page 126.

"Rufus M. Reed, Teacher."

Then on the next page, I have each pupil start the daily record of problems solved, processes mastered, etc. For example:

"Monday, September 25, 1922.
"Problems solved by Thelma Blake.
"Common Fractions, Chapter V. Page 126.
Example 1," etc.

As I understand the purpose of a recitation it is to examine into the pupil's preparation, see what seat work he has done, what problems he has mastered, what difficulties encountered, etc.

When one of my arithmetic pupils encounters some difficult process or problem that he cannot quite master, I give him just enough hints or suggestions to help him solve it for himself. Then I have him make a note of it in his Arithmetic Record. I have him write out just what specific process was giving him trouble, what light I gave him, and so on.

The necessity for the pupil keeping such a record is quite obvious. He knows just what ground he covers each day, each week, each year. It shows the next teacher just where the pupil got to the previous year. It teaches the pupil how to keep a record. And it will be a valuable treasure to the pupil some day after he has reached the years of maturity.

CONTRASTING OF MENTAL PROCESSES IN THE STUDY OF GEOMETRY AND OF MANUAL TRAINING.

By Samuel O. Severson.

Minneapolis, Minn.

It may be maintained that the processes are somewhat the same in these two subjects, since in manual training the learner must utilize the knowledge which geometry as a branch of mathematics gives. Hence it may be resolved in this way: that it is a subject within a larger subject, or that the two are interrelated. The fact is that geometry is a distinct subject calling our mental processes peculiar to itself. It may be further stated that the mental processes in learning geometry are not the same as those employed in applying them. The two subjects in general stand in contrast, inasmuch as the attainment of the knowledge of geometry is in the main mental work, while manual training is, primarily, as the term implies, work with the hands. It is well to bear in mind that the one deals with abstract material and hence must employ abstract thought, while the other deals with things concrete and must call for thinking in the concrete.

The first and in many respects the foremost mental process that is suggested to one thinking about these two subjects is that of space perception. In both subjects there is a recognition of space, but there is a great deal of difference in the point of view. In manual training space is looked upon by the average student as a receptacle or as an external reality embracing all other subjects in the world and no further inquiry is made into the character of space. The object of the student of geometry is to inquire into and to find out all about spacial figures and space relations. This requires a high degree of space perception and is a higher or more complex mental process than merely the perception of forms and distances.

Geometry deals more with the abstract than does manual training. In dealing with symbols like similarity, greater than, less than, sum, difference, equality and the like, the geometry student gets away from perceptual experiences which is an economical mental device which enables one to concentrate his whole attention on the operation. These symbols together with words are the tools for abstraction. In definitions, for example, of a point or a line, we eliminate thickness, color, and everything external and are interested in location merely for scientific purposes. This mental process of abstraction is a form of thin-

ning which is necessary to formulate general laws. It might also be added that the ability to reason in the abstract is a measure of intelligence which normal children acquire gradually while the abnormal do not.

There is less opportunity for abstraction in manual training, since the student is confronted with concrete material and concrete problems.

The usual training a student gets in manual training is almost the opposite in regard to the conception of a point and a line, from what he gets in geometry. He is trained to think of a point as a definite pencil mark on a piece of board or drawing; and a line to him is either a light or heavy line on a board which the saw or chisel must follow. This will not give him the independence from sensory impressions that the student of geometry gets in his work.

To obtain ultimate success as a student of geometry one must from the beginning be trained in analysis. One must in order to attack a problem successfully be thoroughly familiar with the methods of analysis developed especially through experimentation. It often seems a waste of time to a beginner to experiment with a point and a line in order to discover the characteristic relation between them, since all seem so apparent and simple. Even the definitions, axioms, postulates, as well as aspects and properties of figures, seem so elementary that often times they are slighted. But the knowledge of the specific characteristics of the lines, axioms and simple figures will be essential means for solving the more complicated theorems and problems which arise in the order of increased difficulty. The first step in the solution of these will be the analysis and the examination of the various means by which the proposition may be proven.

There is analysis in manual training also, but of a different type. When a student has a piece of wood before him upon which he is to react with ruler, saw, plane, hammer, and other instruments, he is confronted with numerous details some of which he has little or no knowledge of. It would be possible to enter into the execution of the problems without any forethought and attain some degree of skill through many trials and error but to learn the task in the most economical and efficient way, so that there can be attainment of such a nature that the student can execute his next problem with more rapidity and with greater ease and skill, he must stop to analyze, as did the geometrician, the material he has to deal with.

To be able to make proper adjustments so that the attention may be directed to the problems before him, the student can profit by a careful analysis of the tools he has to use. He makes this preliminary analysis by investigating the construction of the teeth of the saw in order to be able to make a distinction between the two strokes. He will also examine the chisel to note that it is beveled on one side; this is of great importance for his future adjustment. This process of analysis is different from the analysis we find in geometric theorems and axioms which is abstract. In this particular analysis of tools the sense of sight is used; sometimes touch is used also. In the analysis of an instrument like the hammer one goes beyond the mere inspection by the sense of sight. By taking hold of the handle and by trying to balance it the student gets through the sense of touch as well as the kinaesthetic sense a better knowledge of how to adjust himself when he is to make the stroke. Of course the sense of touch as well as the kinaesthetic sense will be called into play more fully during the actual process later.

When one is to contrast the mental process of reasoning involved in the two subjects, he enters upon a rather indefinite field. It may be stated, however, that the relative amount as well as the kind of analysis employed in geometry and manual training is a fair index to the relative amount of any kind of reasoning employed.

In geometry the leading mental process is reasoning. A student of geometry has to carry along a chain of evidences in the form of definitions, inferences, axioms, postulates and fundamental laws in order to prove the theorems and solve the problems. In order to be able to formulate generalized conclusions there must be a conscious effort towards discovering and abstracting common characteristics. Besides this attempt to generalize, whish is the most valuable form of modern thinking, there is also an indirect form of thinking employed in geometry. This is sometimes called "argumentum ad absurdum." It consists of disproving hypothesis set up as possible conclusions. The value of this sort of thinking consists in the support and confidence it will give the main truth provided the suppositions are disproved. This form of reasoning has been considered an asset in methods of scientific discoveries.

Reasoning is not so pronounced in manual training, inasmuch as the aim in view is to develop good habits and skill in handling tools and material. A certain amount of reasoning in the larger

sense there must be in any understanding. When I speak of reasoning in a larger sense, I mean the working over and rearranging of experience to form new judgment and new concepts. The lines of demarcation between reasoning, judgment, and concepts are rather vague for the reason that the exact form of reasoning differs with different individuals. A highly trained scientist is more economical in the mental processes involved in reasoning than an unskilled artisan. The same distinction might be made between the student of geometry and manual training. In geometry the reasoning is more logical being based on definite premises. Even seeking new applications along inductive or deductive lines, all unnecessary thought will have to be eliminated. In manual training the line of thought may be more loose and rambling. There is no such definite point of departure in manual training work in seeking relations by combining judgments.

Closely connected with the above-mentioned mental process, viz. reasoning, is comparison which is emphasized in both subjects. In geometry the student has to compare one geometric figure with another, not only by superposition and juxtaposition, but give verbal or written proofs that similar and symmetrical figures are alike. This mental process goes on in the manual training shop also, but usually in a more loose and indefinite way. The student in the shop has as a rule before him a model or drawing and has to compare his work from time to time with these. This is done in many instances in a superficial way, either by glancing at the objects or measuring them with a ruler. There is no logical proof called for in the way of premises or conclusions. If this mental process of comparison in the shop were not a mere superficial imitation, it could be made a factor in scientific analysis. If this process were carried on with the closest of attention and concentration and with the constant check that we have in geometry, the similarities and variations in the individual cases detected might lead to new discoveries.

For a student trained in comparison and analysis manual training furnishes great opportunities to cultivate construction, imagination, inventive power, curiosity, power of observation, self-reliance and originality, which a student in geometry by nature of the subject is compelled to cultivate more or less if he is to succeed. A student in manual training, who after having made a footstool may be no further advanced in the abovementioned mental processes, yet he is rated and given credit

for having finished his task, because there are no definite progressive checks as we find in geometry which deals with subject matter, peculiarly suited to call forth much mental processes. In manual training, on the other hand, superior mental endowments might "shirk and dodge" behind more mechanical skill independent of any mental strain or effort of any sort, that would give rise to any ideas. I am not trying to convey the idea that these mental processes could not be cultivated in manual training as well, if rightly taught; but up to this time manual training teachers have failed to demonstrate that they possess the right methods.

There is less need of memory in manual training. Habit and skill take care of a great many of the details. After several repetitions of a process, the nervous system gets mapped out, so that there will be a definite response for each stimulus. Consciousness functions merely in a general way after these reactions have become fixed.

In geometry on the other hand the student must carry in mind all the preceding definitions, axioms, proofs and the like in order to be prepared to attack a new theorem or proposition.

A NOTE ON THE TEACHING OF BOYLE'S LAW.

By W. C. Hawthorne,

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A verification of Boyle's Law by the student offers one of the very best opportunities for teaching that particular kind of thing which justifies the presence of physics in the High School course. If physics offers no other rewards to its votaries than the acquisition of facts, laboratory technique, or a drill in deductive reasoning, it is a question in the minds of some whether the expense and trouble it takes are justified. But physics properly taught offers the very best sort of an opportunity for a training in inductive reasoning. Not, of course, that every law can be "discovered" by the pupil; still less than more than a very few of the experiments can safely be approached in a state of mental innocence of the result. But the attitude of approach to each new topic, whether by way of lecture table demonstration or preliminary explanation and direction for individual student's work, should certainly be that of the inductive reasoner.

Boyle's Law should certainly be studied in just this way. Let the student be given directions for making the measurements and told to multiply the pressures by the corresponding volumes, with no hint or intimation of what he is expected to get. It will be almost impossible for him to make so crude measurements as not to suggest the law. As soon as possible, let him make a general statement of his results, i. e., *give the law*. Then the law can be verified by other trials, problems worked, and applications made, such as to the expansive part of the curve of the indicator diagram. It seems to me that to tell the student in every experiment what result he is expected to get and to make him feel that he is only to verify the work of others, robs physics of half its value as a means of education, and two-thirds of its fascination.

WHAT COLLEGE MEN THINK OF HIGH SCHOOL CHEMISTRY.[1]

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(Author's note: It has recently been my good fortune to attend the spring and fall meetings of the American Chemical Society at Birmingham and Pittsburgh. In these gatherings, the newly organized Section on Chemical Education, under the leadership of Dr. Edgar F. Smith, "the best loved chemist in America," has been one of the most largely attended. The greater proportion of the participants in the discussion were college professors of chemistry, with a liberal sprinkling of men from industrial fields. The attitude of these men toward the teaching of high school chemistry was indeed interesting, and this paper endeavors to reflect the general, though by no means unanimous, sentiment of their expressions.)

CHEMISTRY'S DEBUT; THE FIRST PRESENTATION TO THE YOUNG FOLKS.

It is the custom in many communities for a large group of young men and women in their middle teens to gather in celebration of the formal introduction of some one whom they expect to know better. Theoretically, at least, they have not known of her existence before; but from the night of this debut, all parties are at liberty to cultivate her acquaintance as freely and fully as they desire, or are able. May I follow this figure for a little while, placing chemistry in the role of debutante, meeting your first protest—that this science is exceedingly ancient—with the answer that it is certainly new to those who assemble before us each year for their introduction to the subject.

No one expects all the early acquaintances made by the debutante to be lifelong; if they were to be, it would be necessary for her to be far more select in her invitations and limit at the outset those with whom she would willingly be intimate in a social way—an impractical distinction. The closer relationships will be in later life. She and her sisters of the coming-out season may attract some into lifelong partnerships, but only those who have formed an especial attachment for them. Miss Chemistry likewise puts her lighter aspects before all who become introduced to her in the earlier stages of their acquaintance, and as time progresses will win from the group several admirers, and a few ardent lovers who swear to devote their lives to her pursuit.

[1]Extracts from address to West Tennessee Teachers' Association, Memphis, November 3, 1922.

What do parents think of this season of getting acquainted? As they push their daughter out under the soft lights of her evening party, she is all smooth loveliness, smiling in answer to smiles, vivacious, and radiant with life. Everyone knows there is a more serious side to her; yet the old folks do not consider it necessary to bring the entire party to witness her at housework, in her kitchen, at her music practice, or in that chamber of horrors where she puts on her curl papers. No, these more fundamental and prosaic aspects are rightly reserved for her intimate friends. As we, as proud papas and mammas of Miss Chemistry, under any moral obligation to put her somber and difficult nature into the foreground as we bring her out for the first time? If the inspirations, the joys of life, the worthwhileness of living, are not improper considerations for the youth of the land, leaving the deeper philosophies for adult contemplation, then may not we select from chemistry in our earliest presentations the thing most worth while for the youths before us, consciously omitting many of the deeper needs of mature workers in the field? . . .

SELECTING MATERIAL AND "KEEPING UP" WITH CHEMISTRY.

I doubt if any chemistry teacher ever feels perfect confidence in his wisdom in selecting just the right subject matter for elementary chemistry. The vastness of the field brings a sense of deep humility. . . .

We all want to keep up with the progress of chemical science yet we grow breathless in the effort, for the pace at which chemistry progresses is prodigious. The Abstract Journal of the American Chemical Society, which lists and briefly describes all articles of original research in chemistry which may be published in the chemical journals of the nations, had, in 1919, 14,698 abstracts in its pages, 18,051 in 1920, and 22,800 in 1921. Nearly 23,000 new discoveries in a year, for the science of chemistry alone! Over 1,900 a month! Over sixty a day! And related sciences which the chemist must follow enlarging their knowledge at a similar rate! A man could not even read the complete reports of research and advance in chemistry day by day. . .

It may interest you to know the distribution of this activity in chemistry, the fields in which the greatest amount of work is being done. Given in order of the number of abstracts published in 1920 (the full reports for 1921 not yet being available), they are:

Patents for new chemical processes	4,432
Biological chemistry	3,138
General and physical chemistry	1,169
Organic chemistry	1,016
Subatomic and radiochemistry	655
Metallurgy and metallography	640
Fuels, gas, tar and coke	583
Foods	580
Analytical chemistry	547
Pharmaceutical chemistry	450
Mineralogical and geological chemistry	423
Water, sewage, and sanitation	387
Soils, fertilizers, and agricultural poisons	377
Acids, alkalies, salts and sundries	375
Electrochemistry	368
Fats, fatty oils and soaps	308
Glass and ceramics	298
Sugar, starch and gums	253
Laboratory apparatus	250
Cellulose and paper	230
Dyes and textile chemistry	219
Paints, varnishes, and resins	212
Inorganic chemistry	199
Petroleum, asphalt and wood products	177
Explosives and explosions	174
Cement and other building materials	154
Rubber and allied substances	134
Leather and glue	132
Fermentation industries	123
Photography	48

. . . The strictly current progress of chemistry is recorded in the reports at the meetings of its workers. Dealing with research alone, not opinions or suggestions, there were given, at the Pittsburgh meeting, 31 papers on biological chemistry, having to do with the nutritive value of foods, ferments, molds, energy values, vitamines, processes of cooking; 20 on fertilizers and soils; 40 on industrial and engineering chemical problems, 26 on gas and fuel; 21 on that familiar mystery, cellulose; 24 on petroleum and its products; 13 on sugar; 14 on medicinal preparations; 24 on dyes; 24 on leather; 23 on rubber; 8 on water and sewage treatment; over 100 on pure science, covering a wide variety of themes; 11 on history, showing the romance of the science, its

proud days of achievement, and dark eras of despair. How impossible for me to bring back what was said at the meeting for the consideration of my classes! How difficult to teach literally up-to-date chemistry, to present the latest, to even be sure of the best! . . .

THE UNDERCONSUMPTION OF SCIENCE.

Taking science in general, the world is not in such dire need of new discoveries and inventions as of the wider spread of the knowledge already possessed, and the more common and efficient use of inventions already available. We have communities where Gutenburg's invention of the art of printing has not yet benefited all the people. . . .

Three years ago a teacher was "fired" in Tennessee for teaching that the earth was a sphere, and moved around the sun. I have personal knowledge of the conditions, and letters which give the details of the community meeting at which this action was taken. . . .

There is such a thing as underconsumption of science in a nation. The production of any commodity, whether of materials or ideas, cannot go too far ahead of the absorptive capacity of the consuming population. Just as the great rush of Von Kluck on Paris in 1914 carried the advance battalions so far ahead of the stronger forces in the rear that they collapsed on the Marne, so the leaders of scientific thought and action in a nation may find it impossible to go on, if for any reason a great mass of stragglers has accumulated far behind them. If any considerable portion of the citizenship of a nation is standing absolutely still in respect to some phase of society's progress, that progress may be forced to stop awhile to bring up these supports from the rear. . . .

Efforts to put science before the people are now much in evidence. Dr. E. E. Slosson, formerly a research chemist, a university teacher of chemistry, then literary editor of the Independent, now brings to bear his peculiar association of gifts in scientific and literary lines as the guiding spirit of Science News Service, sending to newspapers all over North America authentic yet interesting articles on science. Such sheets as these (showing them) are lessons in the new type of Extension Course offered to the people of the land, and, according to Dr. Slosson, thoroughly appreciated by them.

Literary magazines, of which the Saturday Evening Post, the American, the International, are examples, are printing more and

more science, and asking authorities to write for them. This shows that there is a demand coming from the heart of the crowd; for the magazines print what the people want. . . .

In a similar missionary spirit, the American Chemical Society supports the Chemical News Service, broadcasting every few days a set of sheets (showing them) with unique chemical discoveries explained. . . .

PANDEMIC CHEMISTRY.

One of the most freely discussed addresses to the Section on Chemical Education at Pittsburgh was that given by Dr. Wilder D. Bancroft, Department of Chemistry, Cornell University, a leader in pure chemical research. Yet he was advocating "pandemic chemistry," which he explained as "college courses aiming to teach all who will listen, not to be chemists, but rather to know chemistry." The chemical facts which most closely apply to human health, wealth, and happiness, should be matters of common knowledge. Books, newspapers, and magazines will call the attention of the world to the constant advances in chemistry if people want this news; and sometime, somewhere they should be taught to want it.

The chief point of discussion concerning Dr. Bancroft's paper was whether "pandemic science," rather than "pandemic chemistry," was not the thing to be desired. As a sincere believer in the usefulness of general science as a high school subject, it made my cheeks burn to hear what some of the college professors of chemstry said about it. "I once saw *a book* on General Science" was the way many of them began, however, so their lack of acquaintance with the great development of this subject in the last few years must excuse them. . . .

The almost unanimous expression of the assembled chemistry professors was that the high school could do this (spread chemical knowledge to the people) far better than the college and university could, as it reached more people, and touched them at the age of their earliest intelligent enthusiasm. A red danger flag, labeled "College Entrance Board," was waved, of course, but it developed that the chemistry professors who should, in many places do, and in all places will, eventually, have something to say about entrance conditions in chemistry, earnestly favor the idea of high school chemistry being made inspiring, informational, cultural, instead of theoretical and mathematical. . . .

"Better a dinner of herbs where love is, than a stalled ox and hatred." Pupils love the right kind of chemistry. . . .

HOW HIGH ARE THE BARS AROUND THE PLEASANT PASTURES?

There are obvious dangers in popular chemistry. There is no royal road to science. The old way, perhaps, was to give many definitions with few illustrations; the new may give too many illustrations with no definitions. . . .

One is surprised, however, to see the earnest efforts to popularize science in the writings of Faraday, Davy, and other scientists who were masters in their time. . . .

Even the Latin teachers of today are illuminating their subject by the light of modern uses and applications. . .

Unfortunately, the boy who is digging away at a grammar lesson appears to be working harder than one who is reading the Scientific American; and we want our pupils to look as though they are working at school. The Popular Science Monthly may look like a magazine with which to pass away an idle hour; but subscribe to the Monthly Guide to Science Teachers, published by the same Company (showing copies), and see how much real work can be gotten out of it. The teacher may call this "supplementary material;" to the boy it looks like the real thing. It is something like feeding hay to horses; just throw it down, and they go to it. . . .

The wonderful popularity of Slosson's "Creative Chemistry," of which over a hundred thousand copies were taken by the American people; or of Sir Arthur Thompson's "Outlines of Science," which is sweeping the country, show the eagerness of the people to get something they can understand. . . .

It is hard indeed to fight an accusation of "sugar-coating" and "predigesting" science in present day teaching. Yet we no longer cut and bleed for fever, blister with burning metal for rheumatism, nor give as many disgusting drugs as we did. The new ways are more effective as well as more comfortable. . . .

One thing is most assuring; if pupils become really interested in some absorbing chemical incident, they are going to ask "how" and "why?" Then theory suitable to the occasion may be released. . . .

HOW MUCH OF WHAT WE TEACH REALLY STICKS?

Foley's experiments on the college student's knowledge of high school physics[2] shows that what is taught the pupils in good high schools usually goes in one ear and out of the other. No teacher would have the bravery to quizz his own pupils one or two years after they had left his instruction, and publish the results. . . .

[2]Foley A. L., Indiana University *School Science and Mathematics*, Vol. XXII, No. 7, p. 601, Oct. 1922.

At the Pittsburgh meeting, one college professor complained, "They don't even remember the name of the author of their chemistry text used in high school!" Every one looked at Dr. McPherson, and Dr. Newell, both of whom were present, and laughed. "How many have had the same experience?" asked Chairman Smith. All hands went up . . . .

What, then, is the permanent acquisition? If the high school pupil does not continue in the subject, I believe only two things remain; respect for the science, an interest in it which will make newspaper and magazine articles appeal; and a certain amount of resourcefulness in interpreting phenomena and setting up apparatus around the home. . . .

SETTING STANDARDS FOR ACHIEVEMENT IN HIGH SCHOOL CHEMISTRY.

Chemistry teaching must not, of course, run wild. There are certain fundamental chemical facts which a high school student should have learned by the end of the course; and a great proportion of these deal with nomenclature and the mechanics of chemical expression. "To work and live with the Chinese people, it is not enough to merely become familiar with their customs; one must learn their language," said a missionary. It is the same with chemistry.

Certain standard tests have been published in the effort to establish a fair average achievement for a high school chemist in class. Bell (1917) published simple questions, muc hlike an examination; Jones (1917) issued tests on fundamentals, such as writing symbols, formulas, equations, valences; Powers (1911) with later revisions) has established scores for fundamentals as to formulas, valence, classification of chemical substances, balancing and completing equations, range of information, and reasoning power; Rivet (1921) offers a simple "time limit test" of symbols, valences, and formulas; Glenn (1921, with later revision) has scores computed for the fundamentals of chemical biography, formulas, range of information, and problem solving; and Finger (1921) prints a substantial test on the classification of reactions, solutions and ionization, applications and interpretations of theories, laws, and principles, chemical and common names and problems. Powers and Glenn seem to have distributed their tests most widely, and standards obtained from their experiements are soon to be reported. . . .

AT THE END OF THE YEAR.

Let me come back to the opening figure of speech, if you

happen to remember what that was. Miss Chemistry has had a year's "round of activities" with the students. Although it was hard for some to become acquainted with her at first, she no longer was the same air of insoluble mystery, for all the students have seen her in sparkling moods, watched her change her color, seen her on one or two occasions fly into an explosive rage, a few times she has melted into tears, she has shown to some her needles and plates, she has effervesced when it seemed proper, or hardened her heart to stone if it suited her. She has frequently been stirred to action, and she has shown unexplained preference for certain alleged affinities, but an unconquerable indifference in other connections. At the end of the year some students do not really care to know her further—"not really in our set, you know,"—while others have learned to worship her, and may follow her ardently through life. Have we, in our teaching, given this charming creature the most worthy presentation to the society assembled in our presence of which we were capable?

RESPECT THE FLAG.

When you see the Stars and Stripes displayed, son, stand up and take off your hat. Somebody may titter. It is in the blood of some to deride all expression of noble sentiment. You may blaspheme in the street and stagger drunken in public places, and the bystanders will not pay much attention to you, but if you should get down on your knees and pray to Almighty God, or if you should stand bareheaded while a company of old soldiers marches by with flags to the breeze, most people will think you are showing off.

But don't you mind! When Old Glory comes along, salute, and let them think what they please! When the band plays The Star Spangled Banner in a restaurant or hotel dining room, get up, even if you rise alone; stand there, and don't be ashamed of it, either.

Don't be ashamed when your throat chokes and the tears come when you see the flag flying from the masts of our ships on the great seas or floating from every flagstaff of the Republic. You will never have a worthier emotion. For all of the signs and symbols since the world began there is none so full of meaning as the flag of this country.

Other flags mean a glorious past; this flag means a glorious future. It is not so much the flag of our fathers as it is the flag of our children, and of countless children yet unborn. It is the flag of to-morrow, the signal of the "good time coming." It is not the flag of your king; it is the flag of yourself and your neighbors.

Your flag stands for humanity, for an equal opportunity to all the sons of men. Of course, we have not yet arrived at that goal; injustice still dwells among us; senseless and cruel customs of the past still cling to us, but the flag leads the way to righting the wrongs of men.

Our flag is the world's symbol of liberty. That piece of red, white, and blue bunting means five thousand years of struggle upwards. It is the full-grown flower of generations fighting for liberty. It is the century plant of human hope in bloom.—[Col. Alvin M. Owsley, National Commander of the American Legion.

WAYS TO STIMULATE INTEREST IN ZOOLOGY.

ADA L. WECKEL.
High School, Oak Park, Illinois.

There probably has never been a time in the history of education when its problems have been more complex than they are at the present time. Life on every hand is now offering young people the sensational and the spectacular. If by any chance the automobile, jazz music, the theater, or the movies fail to interest them, the press is at their command ever ready to supply them with accounts of real or fictitious scandals, or there is at their disposal an abundance of short stories and of novels. With all of these influences outside of school creating and stimulating this almost abnormal desire for the unusual, it is becoming constantly more difficult in school to create and to maintain any intellectual interests except by methods of which all of us have not or still do not approve. Athletics, dramatics, clubs, school newspapers, and public speaking are the things which our students are enjoying and about which they are talking. Compared with these what does *zoology* have to offer? *We* know that it is filled with phenomena, any one of which is infinitely more remarkable than the spectacular things which are being constantly devised for creating and satisfying the craving for the sensational. But, what have we done to make it appear so to boys and girls of high school age? Has our salesmanship been as skillful and as efficient as that of the influences outside of school? Perhaps the answer to these questions is found in the present enrollment in zoology. Much has been said in recent years, as you know, about the decline of botany and of zoology. Whether all the statistics given in this connection are correct or not, it is certain that there are not so many students electing the biological sciences as there should be.

No subject in the high school curriculum offers material of more vital importance to boys and girls than does zoology. Neither does any subject have materials which are better adapted for spectacular presentation. As teachers of science, however, I believe that most of us have been prejudiced against this type of presentation. It has seemed to us almost like an affront against the ethics of science. But we have been forgetting, I believe, that we are teaching boys and girls, and that the more formal methods of science are not best adapted for them. I think that it is possible to make the process of

digestion, the action of the heart, the phenomena of development, the laws of inheritance, the symbiotic relationships between animals, or the camouflage in the animal world seem just as wonderful and as remarkable to boys and girls as do the adventures of their favorite movie stars in their latest productions. At the same time we can slowly but certainly convince them that their acquaintanceship with the ways and the laws of Nature is giving them an interest to which they can always turn to satisfy the desire for the sensational and the spectacular. In acquiring this information they will, also, be developing the scientific method of attack which should help them to solve sanely and wisely the problems which will confront them in later life.

In spite of my dislike of publicity and of my personal prejudices against doing the spectacular, it has been necessary on a number of occasions in recent years to do both in my zoology work. As a result I have come to appreciate the fact that it is possible to present in a spectacular way much of the material in zoology, and yet not have it lose any of its scientific accuracy or value. Since by the methods which I have used in this connection, I have succeeded in stimulating a little interest in zoology, I thought perhaps my experiences might offer some suggestions to you.

It has been customary in our high school for a number of years to have exhibits of school work. These exhibits are held in the evening about once in two years under the auspices of the Parent-Teachers' Organization. To prevent these exhibits from becoming monotonous it has been necessary to vary the kinds of materials shown. The use of *charts* I have found to be one of the most effective methods for displaying class work and also for giving to the public information which I have thought was important and of general interest. Students have prepared charts on such topics as: House Fly a Disease Carrier; Life History of the Mosquito; Metamorphosis of Monarch Butterfly; Protective Resemblance, the Walking Stick; Inheritance in the Jukes; Inheritance in the Edwards Family; Furs, Real and Imitation; and many other similar topics.

Last year we were asked to take a booth at the annual "Nature Exhibit" held at Marshall Field's store under the direction of the Federated Women's Clubs of this district. Here our problem was complicated by the fact that we had to compete

with all kinds of garden and nature clubs, scout organizations, and individual exhibitors. We were anxious to make our exhibit attractive enough so that boys and girls seeing it would want to come to school to learn what we have to offer as much as, if not more than, they would want to take a walk with the Prairie Club or belong to the Boy Scouts.

This fall a new demand was made upon us. The business men of Oak Park had an "Own Your Home" exhibition, and we were asked to prepare something appropriate for that. We were studying insects when this request came, so we prepared a series of charts on insects which are household pests: the clothes moth, carpet beetle, ant, cockroach, and others.

In spite of the fact that I believed at first that the time spent in preparation for an exhibit was wasted, I have become convinced that there are very few ways in which one can create more interest in class work and in the subject. The public, too, shares in this interest.

A public-spirited woman in Oak Park two years ago offered a prize of $20.00 for the best essay on birds written by any student taking zoology. This stimulated so much interest that she is continuing to offer the prize each year. The subject assigned for this essay last year was: "My Personal Experiences with Birds." It was my intention to have all the essays written on experiences in attracting winter birds. Early in November we made a careful study of the methods for attracting birds. Feeding trays were put up, a lot of seeds were purchased and divided, and suet was also supplied for food. Careful records were then kept by each pupil of the results obtained. In these results, however, we were all much disappointed. There was very little snow last winter and our trays were not such popular feeding places as we had hoped they would be. When the time came for submitting the essays only a few were written on "Winter Birds." Other subjects used were :"Enemies of Birds;" "Observations Made on Nest Building;" "A Morning Walk in the Forest Preserve;" "Bird Photography;" and a "Survey of the Bird Nesting Places in our Block." All of the students taking zoology were required to submit essays. The best were then selected, written and rewritten until they were in as perfect form as it was possible for the writers to make them.

The thing most effective last year in making regular class work interesting was the making of models to show the in-

ternal structure of the frog. They were made of heavy paper, and their construction was similar to that of the manikins used in human physiology. In fact, we named these models "frogikins." I have never found a method so successful for teaching students the parts of the frog and the relation of these parts to each other. Neither have I suggested anything which afforded them so much pleasure.

In the consideration of man as an animal and of man in relation to his environment personal and public hygiene offer a big field of interesting and valuable material. In personal hygiene this year I expect to have charts kept by students in which they record: kinds and amounts of food eaten daily, amount of exercise, number of hours of sleep, number of hours of study, etc. In public hygiene sanitary surveys may be made, trips may be taken to the office of the health department, to the sewage disposal plants, to packing houses, and to all other plants which are concerned with our welfare. This work is especially important in making students see the practical value of zoology.

I have attempted to give you briefly some concrete examples of methods I have used for stimulating interest in zoology. J. Harvey Robinson in "Mind and the Making" says tnat monkeys learn by monkeying, not by apeing. But to become civilized, he says, animals must also ape or imitate. I have given you my experiences in monkeying. I hope that some of you may find something in them worth apeing.

BUILDING BETTER BOYS AT CAMP ROOSEVELT.

By Lillian Ewertsen,

460 So. State St., Chicago.

Two hundred and seventy-three boys buckling down to hard study just at the beginning of the summer vacation seems most unusual. However, this is what happened at the beginning of the summer of 1922 at Camp Roosevelt, known throughout the country as "the boy-builder." The boys in these summer schools were under the direction of the Principal, Mr. Charles H. Smith, Editor of School Science and Mathematics, and his faculty of fourteen. That these boys did buckle down and study hard is shown by the results at the end of the summer. Fourteen of them maintained an average of over ninety in each of two subjects, and were awarded Camp Roosevelt Scholarship Medals as a result. Four others maintained such high marks that

they were placed on the Honor Roll, while of the remaining students all but nine completed the course and received their credits.

It is no mean accomplishment for a boy to go through this strenuous and intensive course and complete a semester's course in each of the two subjects which he takes. Putting in only the forenoon hours, devoting the afternoons to athletics, swimming, military training, hiking, provides a very full and complete day for these campers.

The Camp Roosevelt summer schools constitute one of the most unique institutions of the kind in the country. Coming directly under the Superintendent of Schools of the city of Chicago, as well as the War Department of the U. S. Government, they are financed by a group of citizens who have organized what is known as the Camp Roosevelt Association. Such national organizations as the American Red Cross, the Y. M. C. A., etc., wishing to have a hand in such a worthy undertaking, lend their assistance annually to making the machinery of the camp run perfectly. Each maintains a large staff of representatives, and completely equipped facilities for the proper handling of boys entrusted to their care.

Major F. L. Beals, U. S. A., founder of the camp and now its directing head, is unusually well fitted for his task of leading these growing boys. He has made a thorough study of boy psychology, and in the position which he now occupies during the winter months, that of Professor of Military Science and Tactics and Supervisor of Physical Education in the Chicago public high schools, he has splendid opportunity to meet and study boys in every form of their complex natures.

To provide a program which would be adapted to the hundreds of boys who yearly gather together at the camp from all parts of the country, and ranging in ages from ten to twenty, Major Beals divided the camp life into three sections, the summer schools, which include seventh and eighth grade and all high school subjects; the R. O. T. C. or military division for those older boys who love the soldier-game, and who prefer the physical upbuilding course; and the Junior Camp, for the younger lads.

Here, then, we have a wonderful summer's outing, combined with a summer school second to none, offered to boys from all over the United States, at only a fraction of the charge of the average summer school. Mr. Smith, who during the winter is assistant principal of the Hyde Park High School in Chicago,

said recently: "While all of the divisions of the camp are popular, it is felt because of the unusual opportunities which the summer school affords boys that this feature of the camp is rapidly becoming its most popular division. We try to give every boy what he most needs in his school work back home. Classes are organized in subjects for which there is a sufficient demand, and the following subjects are taught in any event: English, French, Spanish, Mathematics, History, Geography, Motor Mechanics, Woodwork, Chemistry, Physics, Botany, Zoology.

"Each student is required to take two subjects, and a passing grade carries with it a full semester credit. Passing grades depend upon deportment and general conduct, as much as upon recitation. Each student is required to complete forty recitation periods of ninety minutes in each subject. School hours are from 8:00 a. m. until 12:00 m. every day except Sunday. One hour of this time—from 8:00 to 9:00—is devoted to supervised study. The time from 9:00 to 12:00 is divided into two recitation periods. Between classes a short recreation period is occupied with physical drills, games, etc."

In closing, Mr. Smith said: "All I can add is, that if we turn out at the end of this summer the type of boys we sent home at the end of the term last year, we all will feel that we have accomplished something permanent in the building of better boys."

A NOTE ON THE ANTI-EVOLUTIONIST ATTITUDE.

BY STEPHEN G. RICH.

26 Seventh Ave., New York City.

The recent outbreak of anti-evolutionism needs probably to be considered from many angles before we shall arrive at any satisfactory method of dealing with it. Perhaps the most significant portion of it has escaped our attention, while we have been listening to the irrelevancies and vagaries of Mr. Bryan and the people of certain churches in Kentucky.

This significant portion is comprised in two facts:

1. The bulk of the people think of evolution as a "theory" and regard it as far from being solidly established.

2. The bulk of the people believe that evolution means primarily and fundamentally that the human race is descended from monkeys that today exist as such in the jungles of the Congo or Guinea, and that this descent occurred recently.

It is purely a matter of applied science to devise means to meet these difficulties. Until we have faced them, we may expect that the anti-evolutionist attitude will crop up again and again, and possibly at times most harmful to scientific work of great value. It is, therefore, in order to suggest some possible leading-thoughts in dealing with the matter.

So long as we talk of "the evolution theory" or "theories of evolution" in our more or less popularizing speech and writings, we are encouraging this attitude. The popular mind has, moreover, thanks to our discussions in the past, identified evolution with Darwin's theory of natural selection; any attack upon that is thus taken as an attack upon evolution.

To offset this phase of the matter, we may find it advisable to give wide publicity to what actual cases of evolution have been observed. This does not mean the palaeontological evidence; it means that we must collect and present strongly the available data as to actual observed transmutations of species. Several times I have been asked by thoughtful anti-evolutionists for such cases; there appears to be some desire for a "crucial case" which will settle the question as to whether evolution is a fact or not. Such cases as are relevant to this are not many. Ernst Haeckel, as far back as 1876, claimed that he had actually observed transformation of one species of sponge into another: the offspring of one species were sufficiently different from the parent to form a "good" species as determined by the criteria of systematists in that group. The well-known cases of mutation, especially of *Oenothera* as reported by De Vries, are also sufficiently large transformations to be here relevant. The work of Kellogg and others, on the color and pattern variations of certain *Coccinelidae* in California, and the changes undergone through a period of years, would appear also to offer cases in which variability crosses the lines of "good" species, and in which variation proceeds to the extent of separating two groups that would, if not previously known, probably be considered "good" species.

Evidence of this sort will go far to convince the public that evolution is a fact, not a theory. Of course, it must be well and repeatedly presented.

We may also find it advantageous to emphasize strongly the actual known facts as to the descent of man, and in particular the emphasis needs to be laid upon the fact that no scientist holds (or has held, so far as I know), the absurd doctrine mentioned above.

This is essentially a problem in the application of social psychology, and in pedagogy. It will be solved only when we attack it on the basis of aiming to make general the knowledges that we have. These knowledges and the attitudes involved in them will, if we persist and spread them, become effective controls of social thought and action. Thus they offer a good probability of allaying permanently the anti-evolutionist folly.

COAL AND THE RAILROADS.

About half the freight loaded on our railroads, according to an estimate made by a well-informed man experienced in both mining and transportation, is contributed by our coal mines. This portion includes coal loaded at the mines and coke loaded at the ovens, both consigned to consumers all over the country, and coal loaded for the railroads themselves, as well as articles of mine equipment and supply loaded at industrial centers more or less distant from the coal mines. Even though this figure may later be shown, on fuller presentation of the facts, to be somewhat high, the big, outstanding truth is that the coal mines and the railroads are copartners on a large scale in the business of the country. This copartnership, based on mutual interest—the railroads being the largest purchaser of coal and the mines being the largest customer of the railroads—gave special significance to a conference held recently between a representative committee of the American Railway Association and the United States Coal Commission.

The railroad men present at that conference showed their desire to cooperate in the work of fact-finding by suggesting subjects on which they could contribute statistical facts. The perennial topic of car shortage is only the introduction to the larger questions. What investment in railroad equipment is justified to meet the demands of an over developed mining industry? What can the public afford to pay to accommodate its own seasonal demand for coal? The operating officials of the railroads can also point to the effects of seasonal movement of coal and other commodities on the cost of operation of their roads.

The coal operators are themselves not unmindful of the peak demand for transportation arising in part from the seasonal demand for coal. One large mining corporation in the Middle West has several times made its annual appeal to its customers for early purchase of coal in the form of a full page reproduction of a photograph of two huge locomotives snowbound on the track, with the simple legend, "Lest you forget 1917-18." Such a reminder is pertinent every year, for the greater part of the American public either forgets or has never learned the obvious connection between snow-clogged freight yards and delayed coal at the very time when coal is most needed. How much of this seasonal burden on the railroads can economically be avoided is one of the questions the American Railway Association can help President Harding's Coal Commission to answer. Possibly the consuming public can itself also help in lowering the cost both of hauling coal and of mining it.

WASTE OF MONEY AND MEN.

New Capital Warned Away From Soft Coal Mines.

The studies already made by the United States Coal Commission all point to the fact that the bituminous coal mining industry is over-developed. "Too many soft coal mines and too many miners" describes the situation in plain English. In these coal mines more capital is invested and more miners are employed than are needed to produce the coal the country requires. This condition, of course, involves waste on a country-wide scale.

How great is the present inflation of the industry can not be stated exactly at this time but unquestionably the inflation is excessive. Estimates of the excess mine capacity range from 30 to fully 60 per cent above the country's normal demand which for the last five years has averaged about 510 million tons a year. Figured on the basis of their actual output for the best week in 1918, the capacity of the soft coal mines was then 685 million tons. Since 1918, unfortunately, the mine capacity has been further enlarged, and another estimate of it can be made from the average daily output last year: 300 days' work at that rate would have resulted in 840 million tons being mined, or fully sixty per cent more than the normal needs of the country.

How to deflate the coal industry is one of many problems before President Harding's Coal Commission, and its reports may be expected to present facts bearing on this question. It seems plain enough, however, that the industry should not be further inflated by opening new mines. The facts already presented furnish a valid argument against continuing to enlist new capital in the business, thereby opening new mines that are worse than unneeded, for they further spread and thus overtax car supply and shorten the possible working time of mines in the vicinity that are already well equipped to ship 50 to 100 per cent more coal than they ship now. Indeed, the ratings of mine capacity reported to the railroads for the purpose of obtaining cars would indicate that the bituminous mines

of the country have a total annual capacity of not far from a billion tons, instead of the half billion tons needed.

Exceptions may possibly be made here and there to the ban which the investing public should put on coal mine development. A local market not well supplied with coal may warrant the opening of a near-by mine, which would thereby help to relieve the burden on transportation facilities, but it is believed that such exceptional conditions are rare. In the public land States of the West, unfortunately, the Federal Government itself has not been able to discourage coal mine development, for, under the leasing law, the lessee of Government coal land is required to open the mine and to produce coal on a scale proportionate to the acreage leased. There seems to be no legal warrant for refusing a lease to a bona-fide applicant, even though the public interest does not seem to indicate the need of more coal. The result will be that the West will soon find its coal mines and coal miners as badly off as those in Indiana and Illinois, where the working time is too short to pay adequately either owners or workers.

If the public can appreciate the strength of the evidence already available on this subject of over-development, refusal to invest in new coal mining ventures under present conditions will be recognized as both good business and good citizenship. It is plain enough that the country needs not more coal mines but more work for the coal mines we already have. One potent reason that coal is not cheaper to the consumer is that he is supporting a vast surplus of investment and capacity. The large excess capacity can not for long lower the price of coal, however, simply because that condition of things is wasteful.

17,000 MILES OF COTTON CLOTH FOR A YEAR'S SUPPLY OF CEMENT SACKS

If you were owner of a textile mill how would you like to get an order for a strip of cotton cloth 30 inches wide and 17,000 miles long?

An order of that size would mean that over 30,000 bales, or 15,000,000 pounds, of cotton would be used in weaving the cloth; that 1,600 looms would be kept busy every day for an entire year.

Every year textile manufacturers of the United States are called upon to deliver such an order for a single industry. Over 17,000 miles of cloth are needed for new cement sacks alone.

The varied uses of cement demand that it be shipped to every nook and cranny of the country. Practically 90 per cent of the 380,000,000 sacks of Portland cement shipped in this country last year was delivered to the consumer in cotton sacks, each sack containing 94 pounds of cement.

To meet this demand it is necessary for cement mills to keep large stocks of sacks in reserve. At the present time there are approximately 200,000,000 cotton sacks, either in sack storage houses at the mills, or in customers' hands.

If the cement industry were called on to replace all of these sacks at once it would require over 200,000 bales of cotton to make the necessary cloth.

Although the cement companies redeem all sacks returned to the mill in good or repairable condition, about 15 per cent of all cloth sacks shipped fail to come back. This means that 30,000,000 new sacks must be provided annually.

The sack method of shipping cement is very convenient from the consumer's standpoint. He is able to buy the product in as large or as small quantities as needed. He gets it in a convenient package that is easily handled; and when the sack is empty, if it is in good or repairable

condition, it is redeemed at full price by the cement mill from which it came. The consumer also knows that every sack contains one cubic foot of cement. His measuring was done for him when the sack was filled at the mill.

Cement sacks usually get such hard usage that they seldom make more than eight trips from and to the mills. It is a rare thing for a cement sack to make more than two or three round trips a year.

The millions of sacks returned to the mills every year arrive in various sized bundles. These bundles must be sorted and the sacks counted and credited to the customer sending them in. Then the sacks must be cleaned, and the damaged ones sent to the repair department where machine operators make them fit for service again. The smallest holes or worn spots must be detected, or the very fine cement will leak through. After the sacks are carefully repaired they are tied with a wire bond and are ready for refilling. The filling is done by machine through a valve in the bottom—after the sack has been tied.

All of the repairing and accounting is done without cost to the consumer. Many sacks for which credit has been given fail at the packing machines and are a total loss to the cement company. Millions of dollars are involved in the accounting for sacks returned every year.

TEACHERS NEEDED FOR PHILIPPINE SCHOOLS.

High school teachers, primary specialists, and model primary teachers are to be selected by the United States Civil Service Commission for service in the Philippine Islands. Competitors for these positions will not be required to report for examination at any place, but will be rated on physical ability and on education, training, and experience. The rule, which formerly excluded from this examination women who were not the wives, immediate relatives, or fiancees of men examined for teaching positions has been rescinded. Salaries range from $1,500 to $2,000 a year.

As a safety measure in case of fire, upper floors of four Baltimore schools have been closed by order of the school board. The classrooms on these floors will remain closed until fire escapes have been built and the business manager of the school reports that the rooms are safe.

To further their education and gain credit toward college degrees, more than 3,000 teachers enrolled last year in evening classes established by educational extension department of the Pennsylvania State College. More than 100 courses are given in these classes, including education, psychology, English, languages, history, mathematics, music, art, economics, and physical education. In many places the faculty of a local institution gives the instruction.

WITHDRAWAL DEPENDS ON INDIVIDUAL, NOT COURSE.

More than twice as many pupils withdraw from technical courses in the high school as from academic courses, according to a study of three high schools in Cincinnati. R. J. Condon, superintendent of schools, states that this large withdrawal is not due to lack of attractiveness in the practical work, but to the fact that certain types of boys and girls select the more practical, scientific, and technical courses because they can not, or fear they can not, do the work of the more abstract general courses. These pupils would probably drop out before completing the course, no matter what group of subjects they chose.

PROBLEM DEPARTMENT.

Conducted by J. A. Nyberg.

Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. A. Nyberg, 1039 E. Marquette Road, Chicago.

SOLUTION OF PROBLEMS.

761. *Proposed by R. T. McGregor, Elk Grove, Calif.*

If m and n are positive integers, show that the product $2mn\ (m^4-n^4)$ is a multiple of 60.

Solution by J. O. Hassler (former Editor of this Department), Norman, Oklahoma.

$$2mn(m^4-n^4 = 2mn(m^2+n^2)(m+n)(m-n).$$

If m (or n) is even, 4 is a factor of $2m$(or $2n$). If m and n are both odd, 4 is a factor of $2(m+n)$. Hence, 4 is a factor in all cases.

If neither m nor n is a multiple of three, each is of the form $3k\pm1$ and either their sum or their difference is a multiple of three. Hence 3 must be a factor of the expression.

If neither m nor n is a multiple of 5, each belongs to one of the four forms $5k\pm1$, $5k\pm2$. If they both belong to the forms $5k\pm1$ or both to the forms $5k\pm2$ their sum or difference is a multiple of 5. If one is of the form $5k\pm1$ and the other $5k+2$, the sum of their squares is a multiple of 5, as is evident by squaring the binomials and adding. Hence 5 is a factor.

Since the product is a multiple of each of the numbers 3, 4 and 5 and they are each prime to the others, the product is therefore a multiple of $3\times4\times5$, or 60.

Also solved by A. J. Dow, Harvard Graduate School; T. E. N. Eaton, Redlands, Calif.; Michael Goldberg, Philadelphia, Pa.; J. F. Howard, San Antonio, Texas; L. E. Lunn, Heron Lake, Minn.; Nelson L. Roray, Metuchen, N. J.; Anna Thomsen, Kearney, Neb.; Henry L. Wood, Boonton, N. J. John E. Baade, Waco, Texas, solved the problem by using the relation

$$mn(m^4-n^4) = n(m^2+1)(m+1)m(m-1)-m(n^2+1)(n+1)n(n-1).$$

Nelson L. Roray adds the note: Since $2mn$, m^2-n^2, m^2+n^2 are the sides of a right triangle, their product is a multiple of 60 if the triangle is integral. Several solutions called attention to the fact that the exercise involves three theorems: (1) If m and n are positive integers and each is a multiple of 3 or neither is a multiple of 3, then m^2-n^2 is a multiple of 3. (2) If m and n are positive integers and each is a multiple of 5 or neither is a multiple of 5, then either m^2-n^2 or m^2+n^2 is a multiple of 5. (3) The sum or difference of two odd numbers is an even number.

762. *Proposed by Fred A. Lewis, University of Alabama.*

If (ab) means the angle measured from line a to line b, and a, b, c, d are four concurrent lines, prove that

$$\sin(ac)\cdot\sin(bd) = \sin(ad)\cdot\sin(bc)+\sin(ab)\cdot\sin(cd)$$

I. *Solution by A. J. Dow, Harvard Graduate School of Education.*

Let $(ab) = x$, $(bc) = y$, $(cd) = z$, so that $(ac) = x+y$, etc. We are to prove $\sin(x+y)\sin(y+z) = \sin(x+y+z)\sin y+\sin x\sin z$, and this can be done by the usual expansion of both members.

II. *Solution by Peter Van Wyck, pupil, Dickinson H. S., Jersey City.*

$$\begin{aligned}\sin(x+y)\sin(y+z) &= \sin(x+y+z)\sin y+\sin x\sin z\\ &= \tfrac{1}{2}[\cos(x+z)-\cos(x+2y+z)]+\tfrac{1}{2}[\cos(x-z)\\ &\qquad -\cos(x+z)]\\ &= \tfrac{1}{2}[\cos(x-z)-\cos(x+2y+z)]\\ &= \sin(x+y)\sin(x+z).\end{aligned}$$

The following relations were used:

$$\sin A \sin B = \tfrac{1}{2}\cos(A+B) - \tfrac{1}{2}\cos(A+B) \text{ and}$$
$$\cos P - \cos Q = -2 \sin \tfrac{1}{2}(P+Q) \sin \tfrac{1}{2}(P-Q).$$

A third method consists in drawing a line to intersect the 4 given lines and then using the law of sines for the various triangles. Also solved by *John E. Baade; Michael Goldberg; J. O. Hassler; J. F. Howard; H. Lazott, Worcester, Mass.; James Singer, Cornell '26; Henry L. Wood;* and the *Proposer;* also by the following pupils of the *Dickinson High School, Jersey City, N. J.: Chester Kramer, Edward Kuhn, Frank Marshall, Alfred Toussaint, Howad E. Wahbit.*

763. *Proposed by F. A. Cadwell, St. Paul, Minn.*

Without using the *reductio ad absurdum* method, show that if the sum of two opposite sides of a quadrilateral is equal to the sum of the other two sides, a circle may be inscribed in the quadrilateral.

Solution by W. H. Carnahan, Washington, Indiana.

Let the bisectors of $\angle A$ and $\angle B$ meet at O; from O draw the perpendiculars to the 4 sides as in the figure. Then $OK = OL = OM$, and $AK = AL$, and $BL = BM$. Since $AB + CD = AD + BC$, by hypothesis, we find

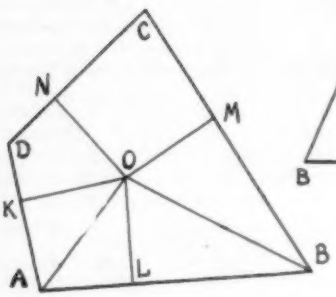
$$DK + CM = DN + CN. \qquad (1)$$

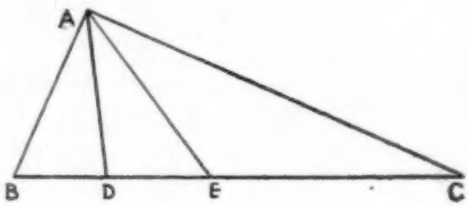
But $DK^2 + KO^2 = DN^2 + NO^2$ and $CM^2 + MO^2 = CN^2 + NO^2$. Subtracting these two equations gives

$$DK^2 - CM^2 = DN^2 - CN^2 \qquad (2)$$

Dividing (2) by (1): $DK - CM = DN - CN$. And from this equation and (1), we get $DK = DN$ and $CM = CN$. This enables us to show $\triangle DKO = \triangle DNO$; hence $ON = OK = OL = OM$, and a circle can therefore be inscribed.

Also solved by *J. F. Howard, Henry L. Wood,* and the *Proposer.*





764. *Proposed by Henry L. Wood, Boonton, N. J.*

Assuming the possibility of drawing the trisectors of angle A of $\triangle ABC$, cutting BC in points D and E, prove that

$$AB^2/AC^2 = BD \times BE/EC \times DC.$$

I. *Solution by C. L. Hunlay, Redlands High School, California.*

Since triangles BAE and DAC have equal angles at A, $\triangle ABE/\triangle DAC = AB \times AE/DA \times AC$; and since these triangles have the same altitude, their ratio also equals BE/DC. Hence

$$AB \times AE/DA \times AC = BE/DC \qquad (1)$$

Similarly from $\triangle$s, BAD and AEC:

$$AB \times AD/AE \times AC = BD/EC \qquad (2)$$

The product $(1) \times (2)$ gives the desired result.

Of the various trigonometric solutions, the following is shortest:

II. *Solution by J. O. Hassler, Norman, Oklahoma.*

Let $\angle A = 3x$. Then by the law of sines,

$BD/AD = \sin x/\sin B$; $BE/AE = \sin 2x/\sin B$;
$EC/AE = \sin x/\sin C$; $DC/AD = \sin 2x/\sin C$.

The product of the first two equations divided by the product of the last two gives $BD \times BE/EC \times DC = \sin^2 C/\sin^2 B$. But $\sin^2 C/\sin^2 B = AB^2/AC^2$ and the theorem is proved.

Also proved by *John E. Baade, Michael Goldberg, J. F. Howard, H. Lazott, Frank Marshall*, and *Nelson L. Roray* who adds the following criticism of current terminology: why assume the possibility of drawing the trisectors of $\angle A$? These trisectors exist. We draw a line because it exists; it does not exist merely because we draw it. The word "draw" is overdone in Geometry, especially in Solid Geometry. Such statements as "Through a given point one plane, and only one, can be drawn parallel to a given plane" should read "Through a given point *there is* one plane, etc."

[In this connection the editor wishes to remark that the department welcomes all criticisms and discussions not only of solutions but also of questions on terminology or pedagogy].

765. *For high school students. Proposed by Elmer Schuyler, Bay Ridge High School, Brooklyn, N. Y.*

Explain the error in the following proof:

Given two triangles ABC and A′B′C′ with AB = A′B′, AC = A′C′ and $\angle ABC = \angle A'B'C'$.

Prove that $\triangle ABC$ equals $\triangle A'B'C'$.

Place A′C′ on AC so that B and B′ fall on opposite sides of AC. Join B to B′. Then $\angle ABB' = \angle AB'B$ because AB = AB′; and $\angle ABC = \angle AB'C$ by the hypothesis. Hence, by substraction, $\angle CBB' = \angle CB'B$ which leads to CB = CB′ = C′B′. And the two triangles are equal, having 3 sides of one equal to 3 sides of the other.

Of the various attempts to find the error in the above proof no pupil called attention to the significant item namely: $\angle CBB'$ *does equal* $\angle CB'B$ but these angles are each zero because the points C, B, and B′ lie on *one* line. These three points are collinear because $\angle C = 180 - \angle C'$ which can be proved by placing the triangles so that AB coincides with A′B′ and having C and C′ on the same side of AB. From the nature of the remarks by the pupils, the editor has concluded that not a single pupil cut any triangles out of paper and placed them as directed for then the answer as given above would have been obvious. Is this an argument for more paper-cutting and experimental geometry in our classes?

PROBLEMS FOR SOLUTION.

776. *Proposed by J. F. Howard, Brackenridge High School, San Antonio, Tex.*

Through the point P in the base BC of a $\triangle ABC$ draw a line XY such that $\triangle AXY : \triangle ABC = m : M$, where X is a point on AB produced and Y is a point on AC.

777. *Proposed by Daniel Kreth, Wellman, Iowa.*

Given the base, the altitude, and the bisector of the vertical angle of a triangle, to construct the triangle.

778. *Proposed by Norman Anning, Ann Arbor, Michigan.*

A textbook on trigonometry has for $\sin(x+a) = b \sin x$ the solution

$$\tan(x + \tfrac{1}{2}a) = \frac{b+1}{b-1}\tan\tfrac{1}{2}a.$$

Show that this solution is consistent with the simpler solution:

$$\cot x = (b - \cos a)/\sin a.$$

779. The editor is frequently asked for solutions of the following:

Solve $\quad x^2+y = 7; \ y^2+x = 11.$

Show how the biquod-quadratic equation, which this leads to, is reduced to a cubic and solve the cubic by means of the trigonometric relation $4\text{isn}^3\theta - 3\sin\theta + \sin 3\theta = 0$.

780. *For high school students.*

In an advertisement in a daily paper are shown three rectangles whose dimensions are: first, 2.6 by 1.6; second, 3.6 by 2.6; third, 4.6 by 3.8. Are these dimensions correct if the rectangles are to represent $2,191, $4,801, and $10,519 respectively?

SCIENCE QUESTIONS

Conducted by Franklin T. Jones

The White Motor Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communicatians to Franklin T. Jones, 10109 *Wilbur Ave., S. E., Cleveland, Ohio.*

Please send examination papers on any subject or from any source to the Editor of this department. *School examinations of all sorts are wanted.*

Clippings similar to that in this issue are wanted. Send them in.

PROBLEMS AND QUESTIONS FOR SOLUTION.

403. (a) *Which is the better physicist—Mutt or Jeff?*

(See the accompanying pictures by Bud Fisher.)

(b) *Can Jeff weigh the cow in the manner indicated? If not, why not?*

(c) *Which one will be cheated if Jeff's method of weighing is accepted? How much at two cents per pound and why?*

404. *Proposed by H. Hugh Jones, Carmi, Ill.*

I have been comparing some physics texts and I notice that Carbat & Chute's *Practical Physics* says the momentum equation is

$ft = mv$ (Force $\times$time equals mass $\times$velocity).

The new edition of Black and Davis does not mention the momentum equation but the old edition of Black & Davis' *Practical Physics* gives the equation as

$ft = wv/g$ (force $\times$time equals weight $\times$velocity divided by gravity).

Since *mass* and *weight* are numerically equal, the equations are the same except for the use of *gravity* in the second.

What is the effect of the use of g in the equation?

Here is a problem to illustrate:

A body of 50 grams is moving with a velocity of 20 centimeters per second. What is the momentum of the body?

According to the first equation, the momentum (ft) is mv, or 50×20 which is 1,000. By the second equation it is wv/g, or $50\times20\times980$.

SOLUTIONS AND ANSWERS.

396. *From Norton—The Motor Truck as an Aid to Business Projects.* Where is the fallacy, if any, in this advertising stunt?

Truck Hauls Thirty Times its Load Capacity

A standard 5-ton Motor truck was attached by heavy chains to a freight locomotive. At a signal the truck was put in motion. There was an instant's halt before the truck could start the dead weight of the locomotive. Then both began to move slowly ahead. The truck towed the engine two city blocks to complete the demonstration.

The locomotive weighed more than 150 tons.

Discussion.

A motor truck can haul on the level more than thirty times its load capacity. The pull here is a standard 5-ton truck against a 150-ton locomotive, or a ratio of 30 to 1. Assuming a level grade, the frictional resistance to pull for wheels on rail is 9 lb. per ton. Then the pull to overcome frictional resistance is 150 x 9 = 1350 pounds.

(Were the heavy chains necessary?)

The tractive ability of the truck is dependent on the grip of the rubber tired wheels on the street pavement. The frictional resistance between rubber and dry pavement is sufficient to exert a pull several times as great as 1350 pounds. In fact the 5-ton truck could tow a number of loaded freight cars as well as the locomotive.

The same truck in loose sand, or up a ten per cent grade through deep mud, would not be able to haul a single trailer in addition to its own load.

The advertising stunt appeals to the imagination of the reader—a truck against a locomotive. The reader is uninformed and thoughtless as to frictional resistance between steel and steel (locomotive on track) and rubber tire on pavement (motor truck).

ANNUAL MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

AUDITORIUM, HYDE PARK HIGH SCHOOL, CHICAGO, ILL., DECEMBER 1 AND 2, 1922.

The general session Friday morning began with several selections by the orchestra of the Hyde Park high school directed by Mr. O. E. Robinson. The Hyde Park High School Choral Club followed. President Alfred Davis then took the chair and presented the speakers.

Address of Welcome: Mr. H. B. Loomis, Principal, Hyde Park High School.

Response in behalf of the Association: Professor Walter W. Hart, University of Wisconsin.

Address: "Social Values in the School Curriculum," Professor Theodore Soares, University of Chicago.

Address: "The Place of Measurement in the Solution of Educational Problems in High School Science and Mathematics," Professor M. E. Haggerty, University of Minnesota.

The afternoon was devoted to the group meetings in the six sections of the Association, to the exhibits of scientific instruments, books, etc., and to an informal reception in charge of the committee on local arrangements.

The annual dinner was held at 6:00 p. m. in the school dining room. The program was as follows:

Toastmaster, Mr. Alfred Davis, St. Louis, Mo.

Group of Songs, Mr. R. R. Raymoth, Chicago, Ill.

Toast: "Changing Ideals in Science Teaching," Professor John M. Coulter, University of Chicago.

Groups of Songs, Mr. Richard Beardsley, Chicago, Ill.

Toast: "Why Teach Science?" Professor Otis W. Caldwell, Teachers' College, Columbia University, New York.

The Annual Business Meeting was held at 9:00 a. m. Saturday in the auditorium.

Mr. I. N. Van Hise, Treasurer, reported:

Total receipts for the year	$2,381.66
Expenditures for the year	1,582.12
Cash on hand	799.54
Number of members for year 1921-22	707
Number of old members paid in advance of 1922 annual meeting	219
Number of new members paid in advance of annual meeting	143

Mr. Teeters, Chairman of the Membership Committee, could not be present but mailed his report to Mr. Van Hise, by whom it was read. This report is appended below.

Mr. H. D. Abells, Chairman of the Necrology Committee, read the report of his committee which is also given below.

Mr. W. W. Gorsline, Chairman of the Auditing Committee, reported the Treasurer's books in excellent condition.

In the absence of Mr. Nyberg, Chairman of the Advertising Committee, no formal report was presented but President Davis reported that six thousand copies of the annual had been distributed and that these were completely paid for by advertising.

Mr. H. R. Smith, Chairman of the Nomination Committee, made the following nominations:

President: Frank B. Wade, Shortridge High School, Indianapolis.

Vice-President: Clarence E. Holtzman, Waller High School, Chicago.

Secretary: Glen W. Warner, Englewood High School, Chicago.

Corresponding Secretary: Charles W. Schwede, Senn High School Chicago.

Assistant Treasurer: H. A. Obenauf, Culver Military Academy, Culver. These officers were elected by unanimous vote of the Association. (The Treasurer, I. M. Van Hise, was elected in 1921 for two years.)

Mr. Wm. J. Ryan, Chairman of the Resolution Committee, recommended (1) that the Association extend a vote of thanks to the speakers on the general and various section programs, and to the local committee and to all others who had contributed to the success of the annual meeting; (2) That the annual meeting be held oftener in cities other than Chicago.

A suggestion was made by the President that some more suitable time might be found for holding the annual business meeting than at nine o'clock Saturday morning. After considerable discussion the matter was referred to the new Executive Committee.

Following the business meeting the sections reconvened for further discussion or for excursions to various places of interest.

ALFRED DAVIS, *President.*
GLEN W. WARNER, *Secretary.*

Minutes of the General Science Section.

The session was opened at 1:30 with the Chairman, Mr. Chas. S. Webb, presiding. About thirty-five members were present. The following program was submitted:

"The Outlook for General Science," Charles H. Lake, First Ass't Superintendent of Schools, Cleveland, Ohio.

"Demonstration of Simple Apparatus in General Science Teaching," Wilbur L. Beauchamp, University High School, Chicago.

"What the Pupils Want in the First Year Science Course," Ernest B. Colleke, Lake View High School, Chicago.

"The Preparation of the General Science Teacher," Professor Otis W. Caldwell, Principal of the Lincoln School, Teachers' College, New York City.

The following were named by the chair to act as a Nominating Committee for the General Science section: Charles S. Winslow, Evanston; W. F. Roecker, Milwaukee; Charles A. Marple, Cleveland.

At 4:20, on motion, the meeting adjourned.

Saturday Session,

The morning meeting was called to order at 10:30 by the Vice-Chairman, Mr. Charles E. Fleming. The Nominating Committee reported, and the following officers for 1923 were elected: Chairman, Charles E. Fleming, Sandusky High School, Sandusky, Ohio; Vice-Chairman, Harold A. Severy, South Division High School, Milwaukee; Secretary, Alice E. Maddock, Lindblom High School, Chicago.

The morning's program consisted of the following: "A Report on Objectives in General Science Teaching," Miss Philipine Creeelius, Blewett Junior High School, St. Louis; "The Use of Motion Picture Films in General Science Teaching," Ira C. Davis, Wisconsin High School, Madison; "What Makes the Course in General Science Worth While," W. F. Roecker, Boys' Technical High School, Milwaukee, Wis.; "Development of a Unit of Work in General Science," Charles J. Pieper, University High School, Chicago.

At 12:00 the meeting adjourned.

Minutes of the Meetings of the Geography Section.

The meetings of the Geography Section were decidedly worth while from two standpoints especially:

(1) All those scheduled for the program were present and read their own papers.

(2) The papers read had been carefully prepared and each had a bearing on some vital phase of geography teaching. The papers were presented as follows:

(1) Dr. Brown, President of State Teachers' College, DeKalb, opened the meeting by stating, in a convincing manner, the need for geography in all Secondary Schools.

(2) Mr. V. I. Brown, Principal of the Community High, Watseka, clearly stated in his paper what the public has a right to expect of the geography teacher in High School.

(3) Miss Ulrich showed, from her own experience, that it is possible to conduct High School field trips that function in the geography work.

(4) Mr. Buzzard gave valuable suggestions as to specific government publications that he had found useful in teaching geography.

(5) Mr. R. R. Robinson, of the Joliet Township High School, explained some original short-cut methods used in his laboratory work grading.

In the Round Table Discussion which concerned the teaching of High School Geography, Dr. Jones definitely stated his opinions which, briefly, may be put under four main heads:

(1) The need of geography in High School.

(2) The place for geography in the High School course.

(3) The content of the geography course.

(4) The organization of the geography material taught.

In the brief discussion that followed, those contributing were unanimously in sympathy with the general plan suggested. The questions that arose concerned ways and means of getting some such plan into operation, and of adjusting such a course to its proper place in the curriculum. The question of the technique of teaching was brought up, but lack of time prevented any discussion.

It is to be regretted that more geographers were not present, but those who did come were optimistic about geography teaching and determined to boost the cause in every way.

At the election of officers, Miss Katherine Ulrich was made Chairman, Mr. A. F. Ewers Vice-Chairman, and Miss Mary Robb Secretary.

Since the meeting, Miss Ulrich has appointed a standing committee, consisting of Mr. Robert Buzzard, Chairman, and Mr. Ewers and Miss Washburn.

Respectfully submitted,

MABEL WASHBURN.

MINUTES OF THE MATHEMATICS SECTION, CENTRAL ASSOCIATION.

The Mathematics Section of the Central Association of Science and Mathematics Teachers held two meetings, Friday afternoon and Saturday morning, December 1 and 2, 1922.

FRIDAY AFTERNOON MEETING.

The meeting was called to order by the chairman, Mr. W. G. Gingery, of the Shortridge High School, Indianapolis, who introduced the first speaker of the afternoon, Professor W. W. Hart of the University of Wisconsin.

The subject of Mr. Hart's paper was the organization of Secondary Mathematics. Mr. Hart urged that mastery, not appreciation, be the end toward which teachers direct their efforts; and for their guidance,

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he gave a list of the chief things to be desired in such an organization for the seventh to the twelfth grades:

1. Minimum list of topics for each grade.
2. Unity, emphasis, and coherence in the material.
3. In each grade, review (preferably indirect) of the essentials of preceding grades.
4. Maximum of new material consistent with mastery.
5. Consideration of technique, as well as selection and arrangement of subject-matter.

Mr. Hart's talk led, as he expressed the hope that it would, to a maximum of discussion ably opened by a paper by Dr. J. M. Kinney of Crane Junior College, Chicago. The general discussion which followed was participated in by Mr. E. R. Breslich, Chicago; Mr. W. D. Reeve, University of Minnesota; Miss Ferguson, Crane High School, Chicago; Miss Sykes, Bowen H. S., Chicago; M. J. Newell, Evanston; and Mr. Bowden, Lindblom H. S., Chicago.

The discussion reached its climax in a motion by Mr. Hart that a committee on organization of three members be appointed by the chairman to study problems connected with the teaching of mathematics.

Professor E. J. Moulton, Northwestern University, in his paper on Accuracy in English, Mathematics and Astronomy Grades, told of a most interesting investigation carried on by Professor Starch of Harvard, Professor Jacobi of Columbia and Professor Moulton. The conclusion of the investigation was that teachers of mathematics, in grading, agree more closely with marks given by others to the same papers and with their own previous grades on the same papers than is true of teachers of either of the other two subjects.

Because of the lateness of the hour, W. W. Gorsline Crane, Junior College, Chicago, cut short his interesting talk on the slide rule. The members of the section were given slide rules to enable them to take part in the operations which Mr. Gorsline hurriedly gave. All the computations which can be made by logarithms, Mr. Gorsline explained, can be done with much less time and effort on the slide rule and be accurate to the third place.

The chairman appointed as a committee to nominate the officers for the new year, Mr. Edwin Schreiber, Proviso H. S., Maywood; Miss Beulah Shoesmith, Hyde Park H. S.; Mr. C. E. Comstock, Bradley Polytechnical Institute, Peoria, Ill.

The meeting adjourned.

Saturday Morning Meeting.

Mr. Gingery again presided at the Saturday morning meeting of the section.

A paper on the Preparation of Teachers of Mathematics in the Junior High School was read by Professor J. R. Overman, State Normal College, Bowling Green, Ohio. Because it is the junior high school teacher who must help the student "to find himself," it is Professor Overman's belief that the training of such teachers should be the equal, if not better, than that of senior high school teachers. To that end he described a three-year and also a four-year course for junior high school teachers.

Almost everyone present took part in the discussion which followed, particularly J. T. Johnson, Francis Parker School, Chicago; W. E. Beck, Iowa City, Iowa; Harold Blair, Kalamazoo; Dr. J. M. Kinney, Chicago; Mr. Hart, University of Wisconsin; and Professor G. W. Myers, College of Education, University of Chicago. The culmination of this discussion was a motion made by Mr. Davis of the Soldan H. S., St. Louis, seconded

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and carried by the section, that the section go on record as favoring minimum preparation for both junior and senior high school teachers at least as far as the calculus.

The inspection of the old mathematical manuscripts, it was decided, should be carried over to next year's program.

Mr. M. J. Newell recommended that two small committees be appointed to consist of one mathematics and one physics teacher in some high school and a mathematics teacher and a chemistry teacher in the same high school to work on some of the problems of the two groups. The section carried Mr. Beck's motion that the incoming chairman appoint these two committees suggested by Mr. Newell.

In accordance with Mr. Hart's motion of Friday afternoon the chairman appointed as members of the "steering" committee Professor Hart, Mr. Reeve, University of Minnesota, and M. J. Newell, Evanston. It was left to the committee to decide their own chairman. In making the appointment Mr. Gingery said that the committee should be a steering committee to direct the energies, he hoped, of all the members of the section.

The chairman thanked those who had helped to make the meeting so successful. Then in the absence of all the members of the Nominating Committee he read their report: for Chairman, Earl L. Thompson, Township High School and Junior College, Joliet, Ill.; for Vice-Chairman, A. M. Allison, Lake View High School, Chicago; for Secretary, Gertrude L. Anthony, High School, Oak Park, Ill.

The motion made by Mr. Smith, University of Minnesota, that the report be accepted and that the Secretary be instructed to cast the ballot was seconded and carried.

The meeting adjourned at noon.

GERTRUDE L. ANTHONY,
Secretary.

MINUTES OF THE BIOLOGY SECTION.

The Biology Division of the Mathematics and Science Association was held at the Hyde Park High School December 1, 1922.

The President, Earnest Hildebrandt, opened the session by announcing the Nominating Committee, Mr. McNutt of Highland Park, Ill., chairman; Mr. S. W. Witmer of Goshen, Ind., and Miss Ella Krache, of Chicago, Ill.

Mr. Hildebrandt, in his introductory remarks, discussed, "What to Teach in the Present High School Curriculum and What Should Be Taught with Respect to the Future."

Professor Otis W. Caldwell, Teachers' College, Columbia University, spoke on "Reorganization of Course in Biology." In his opinion, biology rests upon a year of introductory science, namely, General Science. In discussing the course Dr. Caldwell advanced ideas based upon statistics gathered from an experiment conducted by Mr. Finley of the Lincoln School, New York. Investigations had been made as to what biological information the public was getting through the leading daily papers. Among the seventeen papers examined for the month of June, 1922, were The Boston Evening Transcript, New York Tribune, Kansas City Star, Chicago Daily News, Los Angeles Register, and others. The items had been classified to show what type of biological information was going to press and what the public demands.

The records proved that localities which enjoy the best health are those places which publish the most health knowledge. If this is the case,

Dr. Caldwell puts the question—"Can not the biology teacher be instrumental in getting material for distribution?" At present, it is not available. "Why not take the situation in hand, enlist the English department if need be, and work out papers in the biology classes which can be published?"

The second speaker of the afternoon, Dr. Griffeth, Department of Psychology, University of Illinois, threw new light on the inheritance of acquired characteristics.

Up to the present time evidence on inheritable characters has been unconfirmed. Dr. Griffeth grounded his statements on a new line of experiment—that of rotating the white rat for an hour, a day, a week, even months without stopping. Changes appeared which affected equilibrium, the head became deflected and the rat showed tendencies to walk in a circle. Finally, rats were bred, born and reared to maturity on the rotating plates. Later the offspring were taken from the disk and were bred with normal mates. The descendants showed tendencies toward the inheritance of these new characteristics as far as the fifth generation.

Therefore, the question resolves itself into determining under what conditions can germ plasm be changed. Three phases must be considered:

1. Recombination of germs giving something not wholly new but apparently new.
2. Mutation theory proved inherently unstable.
3. Modification of germ plasm by environment.

Miss Ada Weckle, of the Oak Park High School, discussed Laboratory Aids which stimulate interest in zoology classes.

The first is by spectacular presentation, the second by offering prizes for the best papers, the third making models, e. g., frogakins, the fourth making charts of personal hygiene.

"Out of Door Projects" was presented by Miss Ruth Williston, Botany Department, Oak Park High School, in which an oak tree contest was described, also a survey of pines in Oak Park. Making of model illustrating landscape gardening was described and exhibited.

Jerome Isenbarger gave a number of demonstrations, with an improvised college bench lantern.

At the close of the program the Nominating Committee submitted the name of Mr. ———, Joliet, Ill., for President, Miss Ada Weckle, Vice-President, and Miss Rose Maddock of Englewood, Secretary. All were unanimously elected and the meeting adjourned.

Beulah A. Plummer,
Secretary.

MINUTES OF THE PHYSICS SECTION.

The Physics Section of the C. A. S. & M. T. met December 1 at 1:30 p. m., under the Chairmanship of John K. Skinner. Dr. Lemon's address concerning the work of the committee of the Bio-Physical Society on the topics from physics, with which the biologist must be acquainted, was an eye-opener to many of us.

When next you are tempted to give up in despair in trying to overcome the mental inertia of some slow-witted student, recall The Gospel of Inertia, De Forest Ross' inimitable application of Newton's 3d Law to educational problems. The acting force, it is true, can never be more than the reacting force, but he applied this old, familiar principle to so many new situations, mental as well as physical, that he kept us all interested.

Mr. Keener presented additional data on the results of his questionnaire on objectives. A majority of the teachers, as evidenced by the returns, seem to have agreed that character-building is the prime objective, with

appreciation of and information about the physical universe coming next. Habit-forming and preparation for pre-vocational work follow in importance. This paper called forth, or was the occasion for, considerable discussion of the technique of physics teaching, and revealed a wide diversity of opinion concerning objectives and methods of measuring success in attaining them.

If all branches of physics could be taught with the wealth of illustrative material and practical applications, apparently devoted to "Light," at the College of Education, University of Arkansas, according to the paper of D. H. Markham, of that institution, there would be, we imagine, little lack of interest on the part of the students, or complaints of its bookishness on the part of the critics.

The Saturday morning meeting was given over to reports of the progress of work on standardized tests in the teaching of physics and chemistry, by Earl R. Glenn, of the Lincoln School, New York (Measurement of Results in Physics Teaching), and S. P. Powers, University of Minnesota (Achievements of High School Students in Chemistry). They and their assistants have made out questions, distributed them to hundreds of students, marked, tabulated, and studied the results, and used these as criteria in recasting the questions for second trials. The staggering amount of work reported by these gentlemen obliges us to listen to their conclusions—that new methods of examinations of students, perhaps new methods of teaching, are in urgent demand. Teachers everywhere will hope that they will be able to continue their investigations and report results in future meetings.

The officers elected for the following year were: Chairman, W. C. Hawthorne, Crane Junior College, Chicago; Vice-Chairman, Miss Sara A. McEvoy, High School, Rockford, Ill.; Secretary, Alfred Bjorkland, Harrison High School, Chicago.

W. C. Hawthorne, Acting Secretary.

REPORT OF THE MEMBERSHIP COMMITTEE.

An effort has been made during the past year to expand the membership of the Association above that of the normal growth. The results of this effort can not be entirely estimated at this date as the effect of this work will be felt throughout the coming year.

On the basis that it pays to advertise, the Executive Committee voted $25.00 to be expended in advertising th϶ Association and securing new members. The plan adopted, while seeming more or less intangible, was the only feasible one and may be briefly stated as follows: Each Superintendent of Instruction of the various states was requested to send to the chairman of the Membership Committee the current issue of the directory of the high school teachers of his state. From these lists members were appointed in various localities to work for new members. In addition some 600 personal letters were written to past and delinquent members. About 1,200 letters were also written to prospective members selected from the directories. In addition to these, 600 names were furnished Mr. C. H. Smith who mailed as many copies of School Science and Mathematics to these people at his own expense. While the results up to October of this year did not seem in proportion to the effort expended, later results, however, were more encouraging.

The committee took upon itself the responsibility of distributing 4,500 year books out of the 6,000 published. Mr. H. R. Smith of the Lake View High School, Chicago, distributed 1,000 in Chicago and surrounding territory and 500 were reserved for the meeting. The 4,500 books were distributed to all parts of the United States and some parts of Canada. The

addressing was done without expense to the Association. The same may be said of the 1,000 distributed by Mr. Smith.

It is hoped that our effort in bringing the Association before the science and mathematics teachers of the country has not been valueless and will yield permanent results. I wish to express my thanks to the many men and women in the various states who have so kindly responded to the demands made upon their time and energy. Also to the Executive Committee and the Chicago Section for many valuable suggestions during the year.

Respectfully submitted,

W. R. TEETERS,

Chairman Membership Committee, Soldan High School, St. Louis, Mo.
December 2, 1922.

REPORT OF COMMITTEE ON NECROLOGY.

The committee respectfully records the loss of our number through the death of four members:

I.—STANISLAUS R. ARSENEAU, EARTH SCIENCE, NORTHERN ILLINOIS STATE TEACHERS COLLEGE AT DEKALB.

Stanislaus Regnier Arseneau was born near Beaverville, Ill., August 16, 1891, and died in the Columbus hospital, Chicago, June 21, 1922.

The fatal illness is directly traceable to experiences incurred while in military service in the late world war.

Stanislaus Arseneau entered the Illinois State Normal University at Normal, Ill., in the autumn of 1909, and while in that institution his association with Prof. Douglas C. Ridgley, head of the department of geography, led to the choice of a science in pursuit of which his student and teaching careers were directed.

In the autumn after his graduation in 1914, he taught geography in a departmental school in Decatur, Ill. He had previously taught in the school at Beaverville during the year 1910-11. After two years at Decatur he became a special teacher of geography in the Harvard School for Boys, Chicago.

In the spring of 1917 the call to colors found a ready response in the deceased, and in May, 1917, he voluntarily enlisted in the University of Chicago ambulance company, and was called to active service in June, 1917.

Return to civil life was followed by a year of teaching in the Harvard school. In the summer of 1920 he entered the University of Chicago to complete his undergraduate study, and received the degree of Bachelor of Science with the June class of 1921.

In September he began the work for which his study and teaching had prepared him, having been elected as assistant professor of geography in the Northern Illinois State Teachers' College at DeKalb.

II.—FRED D. MACK, MATHEMATICS, LACROSSE, WISCONSIN.

Frederick D. Mack was born April 29, 1871, at Norwood, Carver County. He attended the public schools of his home town, then graduated from the Glencoe High School and later perfected his education by attending the Mankato Normal, the University of Illinois and the University of Washington. He took up the vocation of teaching and after eight years as superintendent of the Norwood public schools he came to Chaska and for four years was Superintendent of the Chaska schools. He occupied a like position for four years at Adrian and then went west to Washington where he put in eight years in the public schools of Everett

and returning east put in the last three years at LaCrosse, Wisconsin, as teacher of mathematics in LaCrosse High School.

In addition to his educational work he wrote many short stories for magazines and also published several books. He was a lover of the young. He furnished the means for the education of no less than one girl and seventeen boys.

Fred Mack died August 31, 1921, having attained the age of fifty years, four months and two days.

III.—Clara Williams, Bellevue, Kentucky.

Your committee could secure no history in this case.

IV.—Rollin D. Salisbury, Earth Science, University of Chicago.

It is with deep sorrow that the Journal of Geology records the death of its active managing editor, Dean Rollin D. Salisbury. After a severe illness of two and a half months, he passed away on the evening of August 15, within two days of his sixty-fourth birthday. For the past four years he had been the responsible editor of the Journal, while from its founding in January, 1893, he participated actively in the general responsibilities of its editorial management.

His field work was begun under the auspices of the United States Geological Survey as early as 1881 and continued until 1910. It embraces extensive studies on the glacial and other Pleistocene formations of the northern states and lower Mississippi valley. In connection with this, he made a report on Crowley's Ridge to the Geological Survey of Arkansas. From 1891 to 1910 he was geologist in charge of the Geological Survey of New Jersey. He made important contributions to the Geological Survey of Illinois and in 1919 was appointed to the Board of Commissioners in charge of the survey. Besides these official services he made independent investigations in several lines. He was geologist of the Peary Relief Expedition to northern Greenland in 1895, in connection with which he studied existing glaciers under the unparalleled advantages presented in very high latitudes.

Dr. Salisbury was a very lucid writer. The reports of his researches and the texts of the several works he prepared for the general reader and for the students put into easy possession of others what he saw so clearly himself. The printed results of his studies in the field and office will long stand as a lasting memorial to Professor Salisbury's industry and clarity of vision.

Large and important as were these contributions, Dr. Salisbury's greatest service to science lay in his singular success in stimulating and training young talent not only for the teaching of science but for research. This distinguished service began at Beloit College, 1883-91, was continued at the University of Wisconsin, 1891-92, and was transferred to the University of Chicago at its opening, where he took part in the founding of the Department of Geology thirty years ago. For nearly twenty years he was active executive of the department and for the last four years bore its full responsibilities. In connection with this geological service he developed the Department of Geography and served as its head from 1913 to 1918, when he was made head of the Department of Geology. From 1899 onward Dr. Salisbury was Dean of the Ogden (Graduate) School of Science of the University of Chicago. In these varied relations he came into touch with thousands of young minds and gave them effective impulses toward sound scholarship and higher life. The ultimate effects of this work are beyond estimation. Through the growing efficiency and the rising power of the young talent thus inspired by his leadership, Dean Salisbury's greatest service to science and to humanity has only fairly begun.

Harry D. Abells, Chairman.

ARTICLES IN CURRENT PERIODICALS.

Condor, for November-December, *770 South Pasadena Ave., Pasadena, Calif.*, *$2.00 per year, 40 cents a copy.* "The Development of Young Costa Hummingbirds (with four photos), Robert S. Woods; "Evidence of Musical 'Taste' in the Brown Towhee," Richard Hunt; "Notes on the Yellow-billed Loon," Alfred M. Bailey; "Distribution of *Molothrus ater* in California, with the Description of a New Race," Donald R. Dickey and A. J. van Rossem.

Education, for *December, Boston, Mass.*, $4.00 *per year*, 40 *cen's a copy.* "Conversion and Education," George S. Hubbell; "What High School Pup ls Like to Read," H. T. Eaton; "Pre-vocational Projects in Geography," Olive Nolan; "How to Learn Languages—Personal Experiences," William S. De Witte; "The Junior High School vs. the Six-Year High," Albert Renwick; "Discipline in Schools," Florence Sanborn.

Journal of Geography, for December, *2249 Calumet Ave., Chicago*, $2.00 *per year*, 25 *cents a copy.* "Regional Geography of Iberia," Stephen S. Vister; "An Analysis of State Final Examination Questions in Geography," Peter L. Spencer; "The Geographic Setting of the Lacua-Aria Dispute," Preston E. James; "The Significance of Geographic Regions," Helen M. Strong; "A Geographic Unit as Illustrated by the Paris Basin."

Nature-Study Review, for December, *Ithaca, New York*, $1.50 *per year*, 20 *cents a copy.* "Buster Brown, a Sheep," Charles Smith; "Mahogany," John J. Birch; "The Pig," Helen E. Murphy; "Potato Beetle Chronicle," Millie R. Turner; "Common Mistakes in Natural History," Wm. G. Vinal.

Photo-Era, for December, *Boston, Mass.*, $2.50 *per year*, 25 *cents a copy.* "Winter Camera-Joys in New Hampshire, Phil M. Riley; "The Silent Detective," Wilfred A. French; "Decorative Uses of Small Film-Negatives," William S. Davis; "The Photography of Watermarks in Paper," Dr. O. Mente; "The Arnold Arboretum," Allen H. Bent; "Introducing Clouds in Photographs," E. M. Barker.

Popular Astronomy, for December, *Northfield, Minn.*, $4.00 *per year*, 50 *cents a copy.* "Sixty-inch Reflector for Argentine National Observatory (with Plate XXXIV); "Mary W. Whitney" (with plates XXXV and XXXVI), Caroline E. Furness; "The Occultation of Venus, 1923, January 13, as Visible in the United States," William F. Rigge; "The Occultation of Aldebaran, 1923 January 27," William F. Rigge; "Planetary Configurations," Frederic R. Honey; "Twenty-eighth Meeting of the American Astronomical Society" (Continued); "Jacobus Cornelius Kapteyn, in Memoriam" (with plate XXXVII), P. J. van Rhijn; "The Meteoric Procession of February 9, 1913" (Part I), William H. Pickering.

Scientific Monthly, for January, *Garrison, New York*, $5.00 *per year*, 50 *cents a copy.* "Social Life Among the Insects," William M. Wheeler; "The Theory of Relativity and its Influence on Scientific Thought," Arthur S. Eddington; "Fast and Famine," S. Morgulis; "Zoology and the College Curriculum," H. H. Nininger; "Toil as a Factor in Human Evolution," Ralph E. Danforth; "City Growth and City Advertising," Robert M. Brown; "Methuselah of the Mississippi," Dr. R. E. Coker.

BOOKS RECEIVED.

A First Book in Chemistry by Robert H. Bradbury, South Philadelphia High School. Pages xii+687. 13x19 cm. Cloth. 1922. D. Appleton & Co., New York City.

Physics for Secondary Schools, by Frederick E. Sears, St. Paul's School, Concord, N. H. Pages x+658, 13.5x19 cm. Cloth. 1922. F. M. Ambrose & Co., New York City.

Horticulture for Schools, by A. V. Stubenrach, Milo N. Wood, both of Univ. of Col., and Charles J. Booth, Chaffey, Union High School. Pages xxiii+325. 13x19 cm. Cloth. 1922. The Macmillan Company, New York.

Heat, by W. J. R. Calvert, Harron School, Eng. Pages 336+vi. 12.5x19 cm. Cloth. 1922. Longman, Green & Co., New York City.

Shop Mathematics, by John M. Christman. Pages x+321+lxviii. 13x19 cm. Leather. 1922. The Macmillan Company, New York City.

Supervised Study in Mathematics and Science, by S. C. Sumner, Palmyra, N. Y. Pages xvi+241. 13x19 cm. Cloth. 1922. The Macmillan Company, New York City.

Farm Projects, by Carl Colvin, State Supervisor of Agricultural Education in Illinois, and John A. Stevenson. Pages x+363. 14.5x19 cm. Cloth. 1922. The Macmillan Co., New York City.

BOOK REVIEWS

Automobile Laboratory Manual, by Frederick F. Good, School of Education, Columbia University, New York City. Pages xiii plus 186. 13x19 cm. 88 illustrations. Cloth. 1922. $1.50. McGraw-Hill Book Company, New York City.

This book consists of a series of experiments which have been made as nearly progressive in series as possible and it serves as a basis for organizing a laboratory class in automobile mechanics for beginners. It deals with practical work, manipulations, putting together and dissembling the parts, tests for locating troubles, making adjustments, and the doing of minor repair work.

There are seventy different exercises in the text. These exercises are written clearly and in such a manner that the student will understand that which the instructor is talking about without difficulty.

It is splendidly indexed. Mechanically the book is well-made and will stand hard usage. It is one that should be in the hands of every young automobile driver. C. H. S.

The Science of Common Things, a textbook of general science, by Samuel F. Tower and Joseph R. Lunt, English High School, Boston. Pages VI plus 398. 13½x19 cm. Cloth. 1922. D. C. Heath and Company, Boston.

This is one of the latest books on the subject and it surely is one of the very best that has recently come from the press. It represents the experience which has been obtained by long years of instruction by the authors in this subject. The book does not attempt to cover the entire field of science and one of the most important phases of the book is that it attempts to cover the immediate environment of the pupil—things that take place almost daily around about him.

The project method is used throughout the book. There are about 250 problems, about two-fifths of which can be performed at home. The equipment needed in this book has been standardized and a list of apparatus needed is given in an appendix. The diction is splendid and the pupil will have no difficulty in understanding what the writers are trying to say. Most of the half-tones and drawings have been made especially for this book. It is worthy of the consideration for adoption of any general science teacher and doubtless the book will have a large circulation.

C. H. S.

Physics, including recent examination questions, by M. H. Kessel, Clark School, New York City. Pages v plus 122. 15x22 cm. Paper. 1921. Globe Book Company, New York City.

A very helpful book to all teachers of physics who are especially anxious that their pupils should make good in their subject. It is an enlarged

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synopsis of the work covered in any modern text and any pupil who familiarizes himself with the topics discussed in this book will have no difficulty in passing any secondary school examination in this subject. It shows that the author has full command of the subject and has selected the most vital and important topics for discussion.

There are eighteen chapters together with several sample sets of recent examination questions. There are many problems scattered throughout the work. Answers to these problems are given in an appendix.

It is a pamphlet that every modern physics teacher should possess.

C. H. S.

Camp Roosevelt, its history and development, supplement 1922. 45 pages. 12½x19 cm. Paper. 1922. Camp Roosevelt Association, 460 South State St., Chicago, Illinois.

This is a supplement for the year 1922 to the Camp Roosevelt year-book which was published in 1921. It gives a short history of the Association and also general information concerning the camp. A complete list of the personnel is also given, together with a list of the boys attending the camp in the summer of 1922. Also there is printed a list of the boys who received proficiency in drill, good conduct, Red Cross, swimmers, marksmanship, etc.

We are only too glad to give public notice to this camp at this place because it is the largest military summer high school in the world. It is managed and operated on the finest business principles possible. There is in connection with the camp a most excellent high school which operates in such a way that the boys receive without question better instruction than they can receive in any city high school. This is due to the fact that they are obliged to keep proper hours, have proper food, take proper exercises, go to bed at the proper time, inability to be absent from class except in case of sickness, and many other things which are eliminated that would tend to keep the boy's mind off of his work. At the last session of the camp there were eighteen states represented and 110 different high schools. The high school work comes from eight until twelve o'clock. Only two subjects can be carried.

Any parent not knowing what to do with their boys during the long summer vacation cannot do better than to place them in this school. Write for information at Camp Roosevelt Association, 460 South State St., Chicago, Illinois.

C. H. S.

Problems in American Democracy, by Thomas R. Williamson, Smith College. Pages xv plus 567. 14x20 cm. Cloth. 1922. D. C. Heath and Company, Boston.

This text has been written primarily for the purpose of bringing the student in direct contact with the current problems of American life, thus enabling him to have a better understanding of the social, economic, and political themes of his time.

The student begins the study of this book with a historical background of American democracy, its origin and development, and an idea of what may be in the future. The author has had difficulty in condensing even into as brief a volume as this all of the various topics that might be considered under such a heading. But the work has been splendidly done and none of the important phases of our governmental life, it seems to the reviewer, have been omitted. From a teacher's standpoint it will be a wonderful aid to get in explaining the intricate problems that occur from time to time in government problems.

It was written in a clear and concise way, simple, yet convincing.

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be had for 30 cents a single copy. The Mathematical Supplements for 15 cents a copy.

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Nearly every chapter closes with a set of questions, topics for discussion that are hinted at in that chapter. Major paragraphs all begin in bold-faced type with an epitome of that which is to be discussed in that paragraph.

It is printed on not too highly calendered paper, the main body being in ten point type. There are fifty chapters, excluding the appendices.

There is a splendid bibliography, the constitution of the United States, and a splendid double page index of seventeen pages. It is one of the best books in civics yet published, and should be in the class-room of every teacher in civics. C. H. S.

Surveys of the Department of Instruction, Cleveland Public Schools.

This little pamphlet of thirty pages is the first of a series of reports on the surveys of the Cleveland Public Schools. These surveys are conducted by their department of research. It is designed to let the general public know more about what their schools are doing. It shows, too, the progress that is being made in all of the departments of the Cleveland schools. It gives the citizens a fine opportunity of getting in closer touch with the great department which is educating its children.

The table of statistics is complete in almost every phase of the school work in which one may look. It gives the nationality of these children, a graph of the rapidity with which the schools are growing; it shows, too, where the increase in school enrollments have been greatest, also a graph showing the increase in high school graduates, a graph of the housing problem, distribution of the expenditures and money, cost of Cleveland schools as compared with other cities, also many other graphs. The pahpmlet is very useful to all principals and superintendents.

C. H. S.

The teaching of Science in Maryland, State Dept. of Education, Baltimore Maryland.

A state is known by its fruits, especially in the kind of literature that it puts out for its pupils. The State of Maryland has surely issued in its pamphlets on the teaching of biology, chemistry, general science, and physics, something that is well worth while for every science teacher in the United States to become familiar with. In each one of these four sciences there has been issued pamphlets which take up the work in a very progressive and correlated way. These pamphlets cover a year's work in the subject.

The methods of procedure are finely written and each pamphlet contains references to textbooks on this subject as well as containing a list of the apparatus and chemicals needed in the particular course. Unquestionably these little booklets will be a great help to the students in Maryland as well as any others into whose hands these pamphlets may be placed. C. H. S.

General Chemistry, by Harry N. Holmes, Professor of Chemistry in Oberlin College. 1st edition. Pages x plus 558. 15.5x22x3.5 cm. Illustrated. Cloth. 1922. The Macmillan Co., N. Y.

This text, for it is essentially a text and not a reference book, is frankly written for the college freshman and the author does not hesitate to go out of his way to make the subject interesting and also comprehensible to his pupil.

The reader is struck with the businesslike method of the book. The subject of chemistry begins on the first page and we begin to get some atomic theory and then simple formulae and equations as early as on page ten. Molecular and atomic weights are taught in the region of page 78

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described in the November issue by Prof. G. E. Ripley in his article on Hook's Law. Correspondence invited.

and in a simplified manner so that the subject should not forever remain a mystery to the student. Valence (p. 59) is early taught and in a most effective manner, using as an introductory experiment the very clever experiment (attributed to Prof. W. A. Noyes) in which 23mg of sodium, 24mg of magnesium and 27mg of aluminum are allowed to react simultaneously (but under separate gas measuring tubes with) dilute HCl, thus releasing volumes and hence weights of hydrogen that are to each other as 1:2:3 while the metals were used in gram atomic weights. Hence the number of atoms of each metal employed was the same but the number of atoms of hydrogen released (measuring the valence of the respective metals) was as 1:2:3.

Two chapters of organic chemistry are given and one on Colloid Chemistry.

The text has much of originality and of merit. It should have a hearing at every college. F. B. W.

Laboratory Manual of Colloid Chemistry, by Harry N. Holmes, Professor of Chemistry in Oberlin College. First edition. Pages xii plus 127. Measures 15.5x23.5x1.3 cm., with diagrams and photographic illustrations. Cloth. 1922. $2 net N. Y., John Wiley & Sons, Inc.

This new laboratory manual of colloid chemistry is from the pen of a man who would rather consider the curious ways of colloids than eat or sleep or otherwise attempt to delay the crystallization of his own numerous and important colloids.

Most of the experiments contained in the manual have been "tried on the dog" for six years in the laboratories under the charge of the author, although many others from the work of our leading colloid chemists have been introduced.

The book combines to some extent the functions of both text and manual and can therefore be used to good advantaege by those of mature years in chemistry who have not had time to keep up with the rapidly advancing literature of colloids.

For the medical student, the student of geology, the agricultural student and the industrial student as well as for the general student the author maps out courses in the front of the book. Each of the courses is based on a time allowance of at least twelve clock hours per week for one semester.

The book teems with references to other texts and to the literature, and in many cases, quotes or abstracts from the literature.

It is worthy of note that the manual was written at the request of the Colloid Committee of the National Research Council.

F. B. W.

Laboratory Manual of General Chemistry, by Harry N. Holmes, Professor of Chemistry, Oberlin College. First edition. Pages X plus 119 Meas. 15x22x2 cm. Diagrams. Cloth. 1922. The Macmillan Co., N. Y.

This manual was designed to accompany the author's General Chemistry, reviewed above. It has been tried out and thrice revised in mimeograph form before being put into print so it is probably as near fool-proof as a manual can be.

Like the text itself the manual has a chapter on colloid chemistry. It also has a considerable section on the qualitative reactions of the metals. There are so many experiments given that the teacher in charge can select his course from among them.

There are many leading questions introduced at the psychological moment. A preliminary section introduces more or less manipulative work. Like the test this manual should be examined by all teachers of college chemistry. F. B. W.